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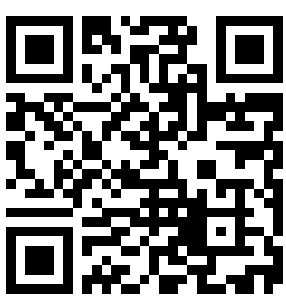

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THE

ELECTRICIAN;

A WEEKLY JOURNAL

OF

TELEGRAPHY, ELECTRICITY, AND APPLIED CHEMISTRY.

EDITED BY DESMOND G. FITZ-GERALD.

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TO OUR READERS.

To-day we complete the third half-yearly volume of the Electrician. "Wonderful!"—says a friend at our elbow,—"what with the high price of your small sheet, your somewhat exclusive subject-matter, and the limited number of those who are interested in conduction, induction, or polarisation, you should have come to a stand-still long ago." Sir, when we first attempted to follow, in regard to telegraphy, the suggestion afforded by a small precursor of this periodical, yclept Our Journal, and to initiate a work which might be of general benefit to students of every degree interested in electricity and kindred science, we followed to the best of our ability certain data with which our experience had supplied us. The subjects appeared obstruse in their character; they were to become less so. Our subscribers were few; but the necessity for intercommunion was on this account but greater. The price of our paper was necessarily high, proportionately to the size of the latter, but by no means higher than absolute exigencies required; and we trust that on this account but very few to whom such a publication was necessary, have been deprived of it. The price, moreover, we may safely promise, will, ere long, be reduced. In brief, Sir, we have worked according to the means we possessed of effecting the object in view, and the result has not hitherto disappointed us.

Some of our readers may remember that a paper "to supply a great want" was recently started, and recently failed. In this case the desideratum was signally overrated. We believe that in the Electrician also a want is supplied; and this is one that we ourselves have often felt. In mounting, with little counsel and no assistance in cases of difficulty, the steep, though earlier, gradients of science, according to our peculiar predilections in this regard, we too often felt the want of a field of publicity devoted to pursuits kindred to our own, wherein we might find matter of special interest, contribute, perhaps, to the interest of others, and solve, or obtain the solution of, any difficulty standing in the path of study. What we then wanted many others now possess. Among our studious readers are many whose names will doubtless, in years to come, become known in connection with our branch of science—careful workers upon Nature's problems, inventors studying some practical application, manufacturers seeking to comprehend the agencies with which they have to deal, and so to perfect their handicraft. Gentlemen, all this will bear its fruits! Even the man to whom the pursuit of science is a pastime rather than a study, is thereby ennobled; and these more earnest investigators, among whom we are proud to mingle, will assuredly meet with their reward, and in due time confer benefits upon science, or upon civilization—the offspring of knowledge.

Medical electricity, which, as an application of science, has latterly been greatly extended, will, in future, occupy its due share of attention. In this branch, we propose to obtain the assistance of a competent therapeutist and physiologist, that our readers may have the opportunity, when desirable, of scientifically applying the wondrous agency of electricity to the cure of disease.

One word more. In the great problems of telegraphy, wherein private interests are sometimes involved, we strive, consistently with even-handed justice, to maintain an equal balance. While giving due prominence to facts on either side of a question, we do not seek to ignore other facts of contrary complexion. Nor would we willingly place our opinion in opposition to that of any competent authority. Our columns are open to all; and truth, whatever may be its influence, is always welcome. "Take a side and keep to it," is, perhaps, a good maxim in politics, and in accordance with the meaner philosophy of wordly wisdom; but it is one that, in most instances, we would conscientiously eschew. Those who know that we have nothing to lose, or to gain, by advocating what we deem to be the right, may furthermore be assured that, were the case otherwise, it would not influence the opinions we may have to express.

32, Paternoster Row,
May 1, 1863.

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THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

[Continued from page 302.]

Daniell's Battery.

In this form of battery two electrolytes, maintained separate from each other, are traversed by the current; the positive element of zinc being immersed in water acidulated with sulphuric acid, or in a solution of sulphate of zinc, while the negative element of copper is placed in a saturated solution of the sulphate of copper. We have seen that, according to the view which is generally prevalent, the action of the couple is supposed to be the resultant of opposite electromotive forces, generated by the oxidation and solution of the zinc on the one hand, and by the oxidation of hydrogen liberated at the surface of the negative element on the other hand, the oxidizing agent in the latter case being the sulphate of copper. Adopting, for the moment, this hypothesis, we can scarcely fail to observe, that what Gavarret terms the negative force in the battery, viz., the oxidation of the hydrogen, should, in this case, be very considerable. For, while in the zinc-copper couple of Volta by far the greater portion of the liberated hydrogen is actually evolved from the negative plate, in this case the whole of the hydrogen is supposed to be oxidised by the copper salt. Again, as the decomposition of this salt is considered to be electrolytic, we should expect to find both its negative constituents, *i. e.*, sulphuric acid as well as oxygen, liberated at the surface of the copper element, while its positive constituent, copper, should tend to pass in the direction of the zinc element, which takes the part of a negative in this secondary reaction. Instead of this, we find that the *acid* tends to pass in the direction of the zinc, a phenomenon which is very evident when the latter is immersed in pure water, and that the reduced copper is deposited in a coherent form upon the copper plate. It is to be observed that this form is peculiar to the electrolytic precipitation of metals; a metal reduced by nascent hydrogen being almost invariably in a condition of loose aggregation.

So far, the hypothesis in question appears open to grave objection; we will proceed to show on what grounds we consider it to be untenable. Water and sulphate of copper held in solution, in water or any other fluid, are both electrolytes, and each possesses a specific degree of electrolytic conductivity. It was, at one time, considered that, in the electrolysis of saline solutions, the direct action of the current is wholly exerted upon the water or other solvent, and that the decomposition of the salt was merely a secondary effect; but it has since been clearly established by Matteucci that metallic salts are susceptible of direct electrolysis, or decomposition by the passage of a current. Moreover, the experiments of M. d'Almeida show that, in a *neutral* saline solution, the salt is *alone* decomposed by the current; and the researches of M.M. Becquerel tend to prove that the action of a current upon two or more electrolytes in admixture, is dependent upon their specific conductivity and relative proportion. Now the power of conduction in electrolytes is equivalent to their susceptibility of decomposition, and, conversely, electrolytes which are readily decomposed by the voltaic current are, in a proportionate degree, good conditions of electricity. But, according to the above hypothesis, we are called upon to assume that the voltaic current, traversing a saturated solution of sulphate of copper, even in a neutral condition, selects water in preference to the far more readily decomposable salt, as an electrolytic conductor; and that the reduction of the metal from this salt is merely a secondary effect of the decomposition of the water.

Again, we cannot wholly accept the doctrine set forth in the following portion of the extract from the work of Mr. Gavarret, given last week.—"We know that the intensity of an electromotive force, depends upon the energy of the chemical affinities brought into play, in originating it. Now, of the three decompositions which produce the *negative* forces, the decomposition of water is that which represents the most powerful chemical action, and the reduction of sulphate of copper is again effected, with greater difficulty than the reduction of nitric acid." The "affinities brought into play" in the battery, are twofold, and act in opposition to each other; we may term them the active or combining, and the resisting, or opposing affinities. Thus, one of the active affinities in the Daniell couple, is that of zinc for oxygen, and this, we hold, determines the electro-motive force of the couple. The opposing affinity in this instance, is that of oxygen for hydrogen, as a constituent of water; the amount of this affinity determines, *ceteris paribus*, the internal resistance of the battery, but does not, in any degree, influence the difference of tensions or electro-motive force. Thus, whether the oxidation of hydrogen, producing the negative force in the battery, be effected by water, by sulphate of copper, or by nitric acid, the electromotive force, supposing it to be produced, will be the same, and the explanation of the difference of power, if observed in various voltaic combinations, thus falls to the ground. The effect of adding sulphuric acid, sulphate of zinc, or common salt, to water, as the exciting fluid of a battery, is to diminish the affinity which opposes the oxidation of the positive element, or in other words, to increase the susceptibility to decomposition in the electrolyte, and in so doing, we increase the conductivity of the fluid, without affecting the electro-motive force.

The celebrated experiment of Professor Faraday, showing that a surface of water is capable of acting as an electrode in voltaic decomposition, shows very clearly the mode in which electrolytic conduction takes place in couples with two fluids, and exhibits in fact nearly the converse of what occurs in the Daniell's couple. A vessel of glass was divided by a partition of mica, extending but half way to the bottom, and a solution of sulphate of magnesia was then poured in, to the level of the lower edge of the mica. Upon the surface of the solution, on one side of the partition, was floated a small disc of cork, soaked in distilled water, and water was then carefully poured upon the cork, until the vessel was almost filled, causing the saline solution to rise on one side of the plate of mica, while, without mixing with this solution, the water occupied the space on the other side. A strip of platinum, constituting the positive electrode of a battery, was plunged into the solution, while the other electrode, also of platinum, was placed in the distilled water. Under these conditions, sulphuric acid was found to be liberated around the positive electrode, while magnesia was deposited at the surface of junction of the solution and the water. In this experiment, the salt evidently constitutes the electrolytic conductor in one portion of the circuit, while in another portion, the function of conduction is handed over to the water. Examining the phenomena more closely, and representing the electrolyte by the chemical formula, $HO.Mn.O.So_3$, we find that O and So_3 are disengaged at the positive pole, while at the surface of junction of the two fluids, Mn combines with O from the water, and H is disengaged at the negative pole.

In the Daniell battery, when the positive element is immersed

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in pure water, the compound electrolyte may be represented by the formula, $CuO.SO_3.HO.$, the constituents being arranged in the order they assume under the effect of polarisation. Let us further represent the zinc, or positive element, immersed in one portion of the fluid, by the sign +, and the negative or copper element, by the sign —. The nature of the couple may then be conveniently shown, by the expression,

$$\underbrace{-CuO.SO_3}_{\text{Sulphate of copper.}}.\ \underbrace{HO+}_{\text{Water.}}$$

in which the electro-chemical nature of the constituents of the electrolyte are also indicated. The *principal* phenomena which result in electrolytic conduction, moy now be readily traced. The + zinc, at the right-hand extremity of the couple, combines with $\bar{O}$, thus effecting the decomposition of water. When the conduction is transferred to the sulphate solution, $\dot{H}$, from the water, combines with $\bar{O}$, of the oxide of copper, the $\bar{S}O_3$ being liberated at the surface of junction of the two fluids, while $\dot{C}u$ is electrolytically deposited at the surface of the — copper element.

(*To be continued.*)

THE SAFETY OF SPANS OF AERIAL WIRE.

The late fatal accident occasioned by the breaking of an aerial wire, under the strain occasioned by a violent gale, is, obviously, but the first of a series which must, in the course of time occur, unless special preventive means be taken. It is true, that this particular wire, from the conditions under which it traversed in proximity to a constantly crowded thoroughfare, was peculiarly liable to occasion a serious casualty; but there are many localities in the city, and elsewhere, in which a similar catastrophe might very possibly occur. Probably, every telegraph engineer has, since the occurrence in question, if not previously, fully noted the danger, in long spans of aerial wire, of leading the wire diagonally even across the streets of populous cities. Where the width of the street is less than the height at which the wire is suspended overhead, the liability of danger to life or limb, by accidental breakage, is obviated, when the wire crosses nearly at right angles to the line of traffic. The chief danger is in crossing a wide space free from buildings; but the necessity for so doing, may, in most cases, without much difficulty, be avoided. The adoption of supports, answering merely a protective purpose, would, in many special cases, ensure the public against the chances of accident.

The strength of wire employed for spans of considerable length is generally in the first instance determined with tolerable accuracy; but means are seldom adopted for ascertaining, at certain intervals of time, the diminution of the original tensile strength which may have been occasioned by corrosion. In the atmosphere of cities, even galvanised wire, as has recently been fully established in France, is liable, after a certain period, to rapid oxidation; and the covering of wires with a coating of anti-corrosive paint, is a process which offers some amount of practical difficulty, and which, unfortunately, is, therefore, but seldom adopted. The tensile strength of wires is also much impaired by the process of galvanizing, and, in an economical point of view, plain unannealed iron wire appears by far the best adopted to resist the effect of strain.* Whatever description of wire be adapted, it is advisable, that the *conductivity* of lengths of wire exposed to oxidation, as well as their tensile strength, should be accurately ascertained in the first instance; so that, by a simple electrical test, the extent to which corrosion has occurred may, in dry weather, be subsequently determined with tolerable accuracy. The wire might thus be replaced, before the corrosion has reached to such an extent as to endanger the safety of the line.

* According to Col. Shaffner, the average comparative breaking strains in English wire per square inch of section, are as follows:—

Plain.	Galvanized.	Annealed.
24·5	19·85	17·

PRACTICAL OBSERVATIONS ON THE EMPLOYMENT OF ELECTRIC CURRENTS IN THE TREATMENT OF DISEASE.

The following valuable remarks upon the physiological effects of electric currents, (voltaic or magneto-electric,) in the treatment of certain forms of disease, are from the pen of Mr. E. W. Tuson, F.R.S., F.L.S., &c., &c.

"The benefit resulting from a proper and judicious application of electro-galvanism, is not sufficiently known or duly appreciated; the subject is of much importance, not only to the medical profession, but to the public at large, as it tends to relieve the sufferings of the afflicted, and accomplishes a cure, sometimes even under the most distressing circumstances.

"The late Mr. Carpue, in his lectures, many years since, remarked, that when mercury produced no effect upon the system, and even after all other remedies failed to have any influence on disease, electricity would produce the most powerful and beneficial result, promoting absorption by its influence and power over the nervous system. The application has been repeatedly employed by me with considerable success, not only when mercury failed to influence the system, but where other medicinal agents were ineffectual, more particularly iodine and its preparations.

"Electro-galvanism may be made to pervade the very centre of the body, to operate on the most distant and remote organs from the surface of the frame, to influence the nervous system, increasing its power, its energy, and its healthy function, removing any obstruction that may have impeded this nervous influence, and thus at once restoring the parts to health and strength. Can any one doubt that electricity acts on the nervous system? Can we doubt that the functions of the frame depend upon the actions of the nerves and influence of the brain? Can we doubt that diseased action often results from the nerves not having sufficient power to produce or excite the organ to perform its functions, which sometimes is essential to health? Do we not know that it is through the nervous agency that the secretion takes place; and do we not know, that certain nerves have particular influence over the parts they are destined to supply? Has not experience taught us, that if certain nerves are paralysed, death immediately follows? Have not experiments taught us, that, if certain nerves are divided, the loss of power or sensation becomes immediately destroyed? And can we, then, doubt the influence of the nervous system upon the frame, producing by its action, by its degree of energy, a certain effect upon the constitution, and a certain temperament of the system? We have in electro-galvanism a power which acts immediately and directly upon the nerves of a part, the nerves of any organ, or upon the whole nervous system, if we please, producing a particular effect according to its application. The restorative power of the animal economy derives its influence from the nervous system; and, where the nerves or spinal marrow become deranged by accidents or other causes, a healthy action will not take place. To exemplify this: a patient came under my care, having had the sides of a drain fall in upon him while at work, causing a dislocation of the right shoulder, a fracture of the eleventh dorsal vertebra, and a broken leg. He lived about thirty days, and his body was examined after death. The shoulder-joint presented the usual appearance of a healthy restoration of the injured parts, but not so the leg: here there was not the slightest appearance of any restorative power of nature towards a cure: both legs were paralysed, so that they had completely lost their nervous action, and no appearance of union of the fracture was to be seen; this was doubtless attributable to the loss of nervous power. Upon reflecting on the nature of this case, we perceive that it requires nervous energy to restore a healthy action; and may not parts or organs sink into a sluggish state, and even assume an unhealthy condition, producing various results from a want of this nervous power? Such cases can only be benefitted, first, by clearly ascertaining the cause, and then using our best exertions to remove it, if arising from want of nervous influence. Nature, in time, or an agent that acts upon that system, can alone restore a due performance of this most important function of the human body. If we examine the course of some of the nerves, we observe that they directly run across or along a main artery. We see examples of this

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kind in the recurrent branch of the nervus vagus, in the carotid plextus, in the axillary plexus, and in the nerves of the arm: we also see the nerves pierce or pass through the divisions of muscles, and we observe the most delicate filaments of nerves pass around a large vessel, that the pulsation of the artery may, by its continual action, excite the nervous influence, and that the motion of the muscles may, by their pressure, produce some degree of excitement in the nerves, so as to stimulate them to perform their action and their function in the animal economy. Deductions may frequently be drawn from some observations or circumstances that present themselves in the course of our practice, and lead to some useful and beneficial results. Frazer Bloxam, Esq., residing at Mitcham, had a very severe compound and comminuted fracture of the leg, which united after the lapse of nearly three months. When fully ossified, the leg was useless; he had no feeling in the toes, and if he tried to place his foot to the ground, it caused him so much pain that he would not even attempt it. He could procure no rest, night or day, from the pain in the ankle, foot, and toes. Some surgeons considered that he had better have the leg amputated, and, so great were his sufferings, that he would have readily consented. He called upon me; and as I had seen relief afforded in a mitigated case of the same nature, I employed the electro-galvanic spark along the course of the nerves sent off from the politeal space with the utmost benefit and greatest success. Upon the third application of this agent, he was enabled to walk across the room, and when he returned to the country, the same day, he threw away his crutches, and walked about the garden. The leg had acquired its power, its feeling, and had entirely lost the pain. He remains quite well, being able to walk and ride, so as to follow the foxhounds. In this case, nature had united a severe fracture, and at the end of this time, might not a want of nervous energy, caused by inaction and want of muscular motion, have prevented him from using the leg, or might not nature have consumed an increased quantity of nervous power in the restoration of the injured parts, so that a deficiency existed in the system, which was incapable of restoring the part to its normal state? Where nature is complete (and the anatomical system abounds with the most beautiful structure), where every part is perfection, it is difficult to suppose that a defect should exist. We may naturally inquire, What caused the pain, the want of sensation, and the want of action in the leg? No doubt the want of nervous activity and power. Were the nerves implicated or pressed upon by the ossific matter? The result proved that this was not the case. The want of power did not occur from inflammation, but was the result of the absence of that harmonious action existing between the nerves of the leg and foot; and the important discovery of Dr. Marshall Hall enables us to account for the pain this patient suffered. Reflex function produced the sufferings and inconvenience experienced, relieved by the action of electro-galvanism upon the nervous system. Cases of a somewhat similar nature daily occur in the metropolitan hospitals, and patients will linger for months, sometimes even a longer period, before they regain that nervous power in the limb which previously existed. Time restores a degree of nervous energy, and we have been too free in recommending the patients to have the parts pumped upon, and in the employment of friction. But we here find an agent that in most cases will restore parts in the course of a few days, by a complete re-union of the nervous system, producing both power and sensation in the part; and I can further illustrate this by the following case: William Purkis, a poor man, at the Marylebone election, met with a compound fracture of the leg, about fourteen months prior to my seeing him. After the union, he suffered violent pain in the leg, which prevented him sleeping, and frequently obliged him to get out of bed at night to tie some wet linen over it, which he found alone gave some relief. He had two ulcers on the leg, where pieces of bone had exfoliated. On the first application of the electro-galvanic shock, it failed to produce any feeling, or the slightest sensation, except a sense of heat at the upper parts of the leg, but no sensation in the ankle or foot. The power of the spark was increased, and passed through the upper parts of the leg, foot, and toes. After a little time, the communication appeared to be complete, and a spasmodic action of the muscles could be seen, proving that the electro-galvanic current passed through the nervous filaments; when the sparks were passed through the leg, the second day, he could not feel them at first, and it was only by bringing them from above downwards that they could be felt at the toes. The sparks were carried along the course of the nerves, and were found to produce more effect at these situations than at others. The benefit this patient found was, the loss of pain, a freedom given to the ankle, sensation in the foot and toes, with every power of motion, so that he could walk without the aid of a crutch or stick. The ulcers healed, and he expressed himself to be well, returning to his work as a bricklayer.

"Another case will be sufficient to illustrate this part of our subject. A lady broke her leg three years previous to the time I was called in to see her, and she was then suffering from violent pain and great tenderness. Upon pressure at the upper part of the foot, so violent was the pain, that she was unable to sleep at night. After I had employed all other means, I had recourse to the electro-galvanic spark. Upon a few applications she lost all pain, and was cured.

"Electro-galvanism has the most decided beneficial effects upon certain cases of paralysis, particularly those occurring from painters' colic. In cases of poison from opium, it is highly serviceable; also in suspended animation; but I am not aware that it has been employed before for neuralgic affections, resulting from accidents, particularly where pain exists, with other distressing symptoms, often rendering the patient's sufferings almost intolerable."—*Published in the Medical Times, February 24th*, 1849.

"Injuries occurring near the large joints are tedious, and often very slow in their progress, frequently attended with chronic inflammatory action. Sprains of the ankle and other joints, are often longer in their reparative process than fractures, and frequently do we see that such injuries cause the patients to be confined to a state of rest for a considerable period. Electro-galvanism may be considered as a stimulant to the nervous system, a stimulant to the most minute fibrillæ, to the most delicate nervous texture, and likewise to the neurilema, or sheath of the nerves, promoting speedy absorption, so that, should the sheath, or even investing membrane of any nervous fibre, be thickened or enlarged by extravasation, or other cause, by stimulating the nerves, promoting absorption, and removing the obstruction, the part will assume a healthy action. Sometimes chronic inflammation, or even disease, becomes established from the want of nervous energy to restore a healthy function, so as to bring the different tissues composing membranes, or even other portions of the frame, to their normal state, and to a proper degree of healthy action. Such may be the condition of the parts after a sprain; the ligaments have been lacerated, the synovial membrane injured, the tendons and their thin sheathes more or less bruised, the cellular tissue distended by extravasation; and it requires a large, or an increased action of nervous power, to restore these several parts to their former condition; but, should the joints so sprained be previously in a weakened state, an increased quantity of nervous power will be required to bring about a cure.

"We have, then, an agent, in electro-galvanism, which acts upon the nervous system; its action excites and restores it to that degree of energy which is necessary to accomplish a cure. The force or extent of the stimulant should be regulated so as not to produce inflammation or other consequences. If this agent is placed in experienced hands, and judiciously applied, it will prove of the greatest benefit, and I trust it will be the means of restoring many joints to a healthy condition. How often do we observe that the want of proper motion in the joint arises from a diminution or deficiency of synovial fluid, occasioned by a laxity of nervous power? This may be remedied by proper application of the electro-galvanic spark, so as to act upon the nerves of the joint, which will induce the membrane to deposit a sufficiency of synovial fluid. How often does this condition of a joint become stiff, and even anchylosed? Or how often do we see this condition of a joint produce a change in its character, and the membrane and bone assume an ivory appearance, which we are no longer capable of alleviating.

"In rheumatism, electro-galvanism will often prove of the greatest benefit; but in such cases the remedy should not only be applied to the trunks of the nerves themselves, but to their more minute fibrillæ that are distributed to the surface of the skin, by which means the membraneous tissue is more stimulated by the current passing through the several parts, from the one side to the other; and, by such means, the sparks may be made to pervade through the centre of the joints, and also to its investing tissues, which will afford relief by producing absorption.

"Electro-galvanism is an agent which produces absorption quicker than any medicinal means that we are acquainted with; and this can be clearly proved by its application to indolent tumors, as it very frequently causes them to be absorbed most readily. After other means have failed, electro-galvanism will completely cure some indolent swellings. A lady, residing near Harrow, applied to me on account of an indolent enlargement, situated beneath the under part of the right side of the lower jaw. The tumor occupied the space between the side of the inferior maxillary bone and os hyoides; all the usual means were employed for the absorption of the swelling, but without success. The electro-galvanic spark was then applied about once in a week, or once in ten days, on account of the distance she resided from town. In the course of a short time the tumor began to diminish, and, ultimately, she was quite cured. Many tumors have been dispersed

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by the aid of this agent; but it may be here mentioned, that more success has attended its applications after medicinal means have been previously employed. In fatty tumors no benefit has been observed to occur from its use; but in glandular swelling, experience has proved to me that it may be of the greatest service; and it is an agent that can be made to enter the most distant parts, or deep-seated swellings, and one that ought to be fairly tried.

"Mr. Abernethy, in his lectures, used to make the following observations, which are applicable here: "Electricity is a part of surgical practice that may be considered as *unique*. All other means operate on the surface; but electricity will pervade the very centre of the body. It may be so managed, as to be made to pervade a tumour, even in the centre of the abdomen. It is a species of stimulation, and may be applied in various degrees of force. Much disputation has been raised as to the manner in which electricity operates on the nervous energy, but I speak of it as a stimulant operating on a local disease. Now, as to its application, you must modify it according to the tenderness of the part; if you stimulate the part too much you will produce inflammation, and the tumor will increase. Now, electrify one swelling. and the swelling subsides; electrify another, and it will increase. What can we think of it? and think we must. We must consider that it acts as a stimulant, and increases the action of a part. You should begin with very small charges of electricity. You would like the patient to feel it a little; but, if it be managed so as to produce a feeling of warmth and tingling in the part, and let that feeling subside, if you saw it did not increase the action too much, then touch it up again, and you might increase the force of the charge. I have very frequently heard people say, if you speak to them on the subject of electricity, 'Oh, I do not think it ever does any good; I have given it a very fair trial; I was electrified every other day for two months.' All this is very possible; and they might have been electrified for two years without any benefit, unless there be some precise mode adopted for its employment and the effect it produces be regarded. This if the worst thing that can be done; it is this practising without intellect that constitutes empiricism; it is blindly adopting, in this way, a power without a principle to guide it, that I abhor above all things." The remembrance of these observations have induced me to employ electricity, and now electro-galvanism, in a number of cases of tumors, with the greatest and most beneficial results. Electro-galvanism is far superior to frictional electricity for many reasons, and much more calculated for surgical purposes. The force of the sparks can be so regulated, that the stimulating effect should not be too great, by which means its employment becomes safe, and can be productive of no ill consequences, even if it should prove of no service. It becomes, therefore, an agent of great practical utility in judicious hands, and under a variety of circumstances can be employed with the utmost benefit. Its effects in promoting absorption have already been mentioned; and, in cases of obstinate stricture, it has been employed with much advantage, producing more speedy relief than any other means that we can use in our surgical treatment. Not only do these observations hold good in stricture of the uretha, but also in some severe cases of stricture of the rectum. I might here detail the method of employing this agent; but I am always most willing to enter into a personal explanation with any of my profession, upon this or any other subject that will benefit or promote science.

"Indolent ulcers, and even scrofulous sores, frequently result from the want of a proper nervous energy in the part; a want of tone in the nerves to produce a power sufficient to cause them to heal and promote a healty action. We know that scrofula is a peculiar action affecting the lymphatic vessels and their glands; these parts are the immediate seat of this complaint; but let us look deeper into the cause, and I firmly believe that we may trace it to the nervous system. If so, have we not it in our power to benefit such cases by electro-galvanism? My experience warrants this opinion, and my observations clearly lead me to believe, that great and permanent benefit may result in a number of hopeless cases that exist in this great metropolis. Ulcers may have a modified current passed through their whole surface, even if ever so extensive: and medicinal agents may, if necessary, be employed by the same means, which will produce the utmost benefit. By the aid of electricity, we have been able to decompose a solution of sulphate of copper, and restore it to its primitive metallic state; we see this in the electrotype, and I look forward to a period when we shall, by similar means, be able to produce some greater and even more advantageous results upon the human frame, bestowing permanent benefit upon the afflicted sufferer.

"In cases where it becomes advisable to stimulate the more minute fibrillæ of nervous filaments which are distributed upon the surface of he skin, arising from the main trunks of nerves connected with the deeper-seated branches of a part, it can be accomplished with much advantage. In cases of obstruction to the performance of any natural function, electro-galvanism will be most serviceable in stimulating the nervous action, and thus restoring the organ to a state of health. Medicinal agents do much in the treatment of disease; but electro-galvanism will do more, and produce a quicker result, and much permanent advantage may be looked forward to from its proper application.

"In cases of sciatica, after blisters, colchicum, morphia, warm baths, acupuncturation, and where all the usual remedies have failed to give relief, electro-galvanism may be safely recommended with every chance of success; benefit will be felt even after the first or second application; and the patient will solicit a repetition of this agent, as affording the greatest relief."

POETRY OF SCIENCE.

OH say not science lacketh charms
To woo the poet's pen,
To swell the pages of romance,
Or thrill the souls of men.
Her's is a realm of fairy land,
A scene of endless change,
Where eye and ear are all confused
With wonders passing strange.

She binds the eternal elements,*
She yokes them to the plough,
And iron steeds with hearts of fire
Speed at her bidding now;
Deep in the ocean's solitude
She her bright name engraves,
Unscathed she treads its golden sands
And cleaves its surging waves.

She joins the nations of the earth
With mystic net-work bands,
Binding in common brotherhood
The peoples of all lands;
Whilst through these wondrous arteries
The lightning pulses thrill,.
Bearing glad news of "peace on earth"—
To all mankind, "goodwill."

She bands their orbits, and the stars
Speed on their track of light,
Sparkling afar in heaven's dark sphere
Like glories in the night;
The planets feel her lion grasp
As their bright paths they run,
And with relentless laws she guides
The chariot of the sun.

The trees relate their fairy tales,
The plants unfold their store
Of wisdom and design, and tell
Truths never dreamt before.
The lightning plays around her feet
And does her bidding well;
The very stones break forth in song—
List' to the tales they tell.

They tell how chaos ruled—how earth
Lay wrapped in death-like sleep,
How silence reigned in majesty
And darkness veiled the deep.
They tell how life uprose on earth,
How forests clothed the land,
And step by step reveal the work
Of HIS Almighty hand.

Behold another votary still—
The light her aid has given;
Light, whose bright beams of purity
Rushed angel-winged from heaven;
Then fair aurora lit the north
And shook her streaming bars,
Then earth awoke, awoke to life,
And sang the morning stars.

Yet learn, Enchantress, that thy power
A limit still must know,
Thus far, O Syren, is thine own,
Further thou canst not go.
In councils of eternity
HIS secret ways were planned,
Ways that elude thy piercing eye—
Defy thy iron hand.

Ages of dim futurity
Shall own thy powerful sway,
Till man with all his wondrous works
Shall pass from earth for aye.
Till then reveal him nature's page,
Unfold his Master's will,
Guide him in paths of light and truth
And lead him upwards still.

HAVERFORDWEST, *November 1st*, 1862,

* Bridges unsupported by arches can be made to span the foaming current, man shall descend to the bottom of the ocean safely breathing and treading with firm steps on the golden sands, never brightened by the light of day. Call but the secret powers of Sol and Luna into action, and behold a single steersman, sitting at the helm guiding the vessel which divides the waves with greater rapidity than if she had been filled with a crew of mariners toiling at the oars. And the loaded chariot, no longer encumbered with panting steeds, darts on its course with relentless force and activity. Let the simple elements do their duty; bind the eternal elements, and yoke them to the same plough.—*Friar Bacon's Prophecy.*

MR. F. C. WEBB "ON ELECTRICAL ACCUMULATION AND CONDUCTION."

THE following notice of the first part of Mr. Webb's treatise has appeared in the *Mechanic's Magazine*:—

It is but seldom we have to notice anything strikingly novel or original in the form of a treatise on electrical science. Works on electricity are,

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for the most part mere compilations, and the authors generally appear to copy and follow each other without much difference of opinion or novelty of doctrine. The present work, however, will afford some new and interesting views of electrical phenomena to those who study the latter from a mathematical, or, rather, from a geometrical point of view; that is to say, to a large section of inquirers in this branch of science. In the first part, which we now have before us, the difficult questions relating to electrical accumulation are brought within the reach of rule and number, and the practical electrician is shown that he may calculate the resistance to electrical accumulation, in much the same manner as he calculates the resistance to electrical conduction. It will be perceived, from what we have said, that the work is intended for the more advanced student of electrical science, rather than for the beginner, who might expect to find in it descriptions of electrical machies and batteries, or the details of electrical manipulation.

We may follow the author through a few of the first steps of the work, which will be sufficient to show the general character of this contribution to our electrical knowledge. We commence with the fundamental axiom, that, "whenever electrical generation occurs, whether by chemical, frictional, or thermal action, exactly equal amounts of electrical action of opposite nature occur on the opposite sides of the source of generation." If we require to obtain in a free state a certain quantity of *plus* electricity, termed also vitreous electricity by those who hold the double-fluid theory, we may readily produce it by means of the electrical machine or the voltaic battery; but we necessarily at the same time liberate an equal quantity of *minus* or resinous electricity. We may, therefore, at the same time that we "accumulate" the plus electricity upon an insulated conductor, obtain the minus electricity as a charge upon a similar conductor. In so doing, however, we find a greater difficulty in obtaining a charge of given amount, or we require a higher electrical intensity than if we connected one "side of the source of generation" to an insulated conductor, and the other to earth. The reason of this will be found explained at p. 66, *et seq.* The readiest means of charging a conductor, say with plus electricity, is to connect to earth the rubber of the electrical machine, or the negative pole of the battery, and to establish a conducting communication between the prime conducter of the machine or the positive pole of the battery, and the body upon which the electricity is to be accumulated.

This brings us to a point upon which Mr. Webb lays great stress, and which indeed is one of considerable importance in regard to the due appreciation of some of the main points of electrical theory. What becomes of the electricity generated on that side of the source which is connected to earth? The great majority of writers, among whom are Professor Daniell, Sir W. Snow Harris, and Messrs. Lardner and Walker, assume that this electricity becomes distributed over the indefinitely large surface of the earth, and is thus "virtually annihilated." The author, on the other hand, maintains that it becomes accumulated upon the nearest conductor surrounding the body which is charged with the opposite electricity.

"The electricity generated at that side of the source in connection with the earth, is as much conducted to, and distributed over the adjacent opposing conducting surfaces, as the other electricity is spread over the insulated conductor, and thus the outer opposing surface is in every respect as much a charged surface as the prime conductor, the difference being only one of degree." The following experiment is suggested as being calculated to decide the question:—An electrical machine is placed within an *insulated room*, the rubber of the machine being connected to the walls. Upon charging the prime conductor with positive electricity from the excited glass disc of the machine, the inner surface of the conducting material of which the room is formed acquires a negative charge of exactly the same quantity as the charge upon the prime conductor. That this is the case would be shown by bringing this conducter into conductive communication with the walls of the room, thereby neutralizing the charges and removing from both surfaces every trace of free electricity. Now, if the room be uninsulated or connected to earth, we have ample evidence to prove, that, the effect of charging the prime conductor of the machine would be precisely the same as under the former conditions, the inner surface of the chamber becoming negatively charged, and none of the negative electricity generated being conducted to earth and distributed over its surface.

The assumption that every time a conductor is charged with plus electricity, the negative charge is distributed over the whole surface of the earth, is clearly untenable; and Mr. Webb has rendered a service to electrical science in clearly pointing this out. In every case we find that the opposite electricity becomes accumulated at the nearest possible distance from the surface of a charged conductor. The conditions which prevail in a charged Leyden condenser are common, therefore, to every instance of electrical accumulation. In the Leyden jar, the distance, or thickness of the dielectric, between the oppositely-charged surfaces, which determines the "inductive resistance" to charge, is inconsiderable; and the quantity of the opposite electricities which can be accumulated, under a given intensity, upon the conductive surfaces, is therefore comparatively great. The term inductive resistance is employed to express the converse of what is know as "inductive capacity." A formula for the inductive resistance of cylinders, derived from the well known expression of Ohm for prismatic resistances ($R = \frac{l}{s}$), has already been given by M. Gaugain, who, has Mr. Webb observes in the introductory notice to his work, has pointed out the general applicability of Ohm's law to problems of electrical accumulation. Messrs, Thomson, Siemens, and Varley have also adopted, to a certain extent, the method of treating the resistance to accumulation in the same manner as Ohm has treated the resistance to conduction, a method which forms the principle characteristic of the present portion of Mr. Webb's treatise.

Applied Chemistry.

ON ARTIFICIAL STONES.

BY PROFESSOR D. T. ANSTED, F.R.S.

THE following paper was read in Section G at the Cambridge meeting of the British Association:—

The various compositions that have been invented from time to time to replace natural stone by substances cheaper, more convenient, or more durable than any that can readily be obtained on the spot where the stone is required, are so numerous that it would be impossible merely to name them without occupying much time; and a mere enumeration could have little or no interest. My object in the present communication is to direct the attention of the Section to the different classes of material that have been found available; to point out the principles involved in each, and the special advantage and disadvantage each possesses; to refer to a new, and, I believe, an important material; and to suggest the bearing of the whole subject on that of the preservation of stone from decay. Having for several years, and especially during and since the Exhibition of 1851, taken great interest in the subject of constructive material and the preservation of stone, and having lately been one of a Committee of Inquiry concerning the state of the stone of the Palace at Westminster, I have learnt from experience how little the whole subject is understood, how vague are the notions of intelligent practical men—builders as well as architects—and how difficult, if not impossible, it is for architects, engineers, and builders to determine, by any series of experiments lasting only for a short time, whether a method proposed is likely to have any practical value when applied on a large scale.

The artificial stones hitherto used may be grouped under one of three heads. They are either (1) terra cotta, or manufactures of plastic clay burnt in a kiln; (2) cements, manufactured from a certain kind of limestone containing foreign ingredients of such a nature that when converted into lime by burning, the lime thus made possesses the property of setting very rapidly and firmly when wetted; (3) siliceous stone, obtained by burning in a kiln sand and other substances moulded with a solution of silicate of soda, which is converted into a kind of glass, firmly connecting the particles. I omit plasters, as rarely exposed to the weather.

Terra Cotta.—The advantages of this material are, (1) its cheapness and the abundance and universal distribution of the clays of which it can be made; (2) the facility with which it can be moulded to any required form; and (3) the pleasant colour of the material when uninjured by long exposure to weather. The work recently executed at the Horticultural Gardens at South Kensington is a favourable specimen. The disadvantages of terra cotta are, (1) the uncertainty of the result, owing to the great and unequal contraction of all clays in burning; (2) its want of power to resist damp and frost whenever there is the slightest flaw, whether produced before or after burning, (3) its brittleness and want of strength; (4) its exposure to a disagreeable green vegetation in damp air after a few years weathering. Terra cottas are better adapted to a dry than a moist climate.

Cement.—Whether of the kind called Puzzolana, Roman, or Parker's, or Atkinson's, or any modification of these, all the cements are similar in their nature. The advantages of cements used as an artificial stone are, (1) its cheapness where made, and its ready transport; (2) its not requiring the kiln, but setting at once without contraction; (3) the facility of moulding and making up the material from the manufactured cement supplied; (4) its great strength when well made. The disadvantages are, (1) that it cracks and peels badly when exposed to frost and damp air; (2) that it is very irregular, some samples yielding a much harder, better, and more lasting stone than others, without apparent reason; (3) that it is subject to a green vegetation, like terra-cotta. These disadvantages do not all apply to its use in making concrete, for which it is admirably adapted.

Siliceous Stone.—This is manufactured under a patent by Mr. Ransome. It attracted attention at the Exhibition of 1851, and has since been much used. Its advantages are, (1) the extreme uniformity of its texture; (2) the almost entire absence of contraction, and its freedom from cracks

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and flaws produced during burning; (3) its complete resistance to all kinds of weathering, to which may be added (4) its pleasing colour and tint.

On the other hand, among the disadvantages are (1) its cost, which is greater than for either of the other kinds of artificial stone; (2) its being subject to a white efflorescence of salt, and a green stain from damp, both of which take away from its value for ornamental purposes, for which it is otherwise admirably adapted.

The mechanical and chemical principles involved in these different contrivances are as follows:—In terra cotta the material is a kind of clay purer and more free from foreign substances than common clay, and mixed with dust from pottery already made. The manufactured article is thus a superior fire-brick. The burning produces little chemical change or metamorphosis, but the condition after burning is so far different that ordinary exposure will not bring back the original texture of clay. Of closer texture than brick, there is less absorption from the surface; but in ornamental work, there are always flaws enough to render frost following rain dangerous and injurious. In other respects the material itself is little more liable than brick to injury from exposure.

In cement the raw material is carbonate of lime, with a certain but variable proportion of foreign substance, of which clay or silicate of alumina is an important and even an essential part. All the varieties of cement stone, such as the stones called septaria and other nodules, in the London clay at Harwich, or the Kimmeridge clay in Dorsetshire, or the Lias in the Midland Counties, and the north or the mud of the Medway and Thames, agree in this. On burning this material the limestone is converted into lime, and the condition and proportion of the foreign material determines the value of the resulting cement. It is called hydraulic cement as setting with almost any required rapidity when properly mixed with water, and this in damp air, during rainy weather, and even under water, absorbing no more water than is necessary for consolidation. Under various names, pozzuolana, Roman cement, Parker's cement, Atkinson's cement, &c., this valuable material has been used from time immemorial, and is especially adapted for making concrete where a large proportion of foreign substances is introduced. As an artificial stone, although it hardens on exposure, its composition is too irregular to justify a very extended use. In the process of setting, the lime first mixes with water and becomes hydrate of lime, and is then rapidly converted into silicate of lime, adhering in thin films to itself and to foreign bodies with which it is in contact.

The siliceous stone of Mr. Ransome consists of sand and foreign substances, worked up into a paste with the fluid silicate of soda. If left to dry in the air it would fall to powder, but being exposed to a high heat in a kiln a chemical action takes place. The alkali of the silicate of soda "combines with an additional quantity of silica supplied by the sand, &c., with which it is incorporated, and become converted into an insoluble glass, firmly agglutinating all the various particles together into a solid, compact substance." No sensible contraction takes place in burning, and cracks rarely occur.

The resistance to weather offered by these three kinds of artificial stone may be thus stated:—1. Terra cotta, contracting irregularly in the kiln, is subject to cracks and flaws, into which water penetrating and expanding during frost, a peeling and splitting of the material naturally follows. It is almost certain, from the nature of the case, that delicate and ornamental work should be more liable to such injury than straight work and plain surfaces. 2. Cement, owing to the want of homogeneity in the raw material, is also very subject to flaws and cracks, and is injured by damp and frost like terra cotta. Both terra cotta and cement require painting in London and elsewhere. 3. The siliceous stone is rarely flawed in the kiln, but, even if it is, the stone does not crack, or the surface peel by exposure to damp and frost, owing to the nature of the cement, which is, in fact, glass. It is also worthy of remark that this material obtains its greatest hardness before it leaves the kiln, whereas cement gradually hardens, and continues to harden for many years if it be not destroyed before the induration is sufficiently advanced.

During experiments made in the laboratory on various methods suggested for preserving stone by a section of the committee recently appointed by the Board of Works in reference to the Palace at Westminster, Dr. Hoffman, Dr. Frankland, Mr. Abel, and myself being members of this sub-committee, a very remarkable material was submitted by Mr. Ransome, and experimented on to some extent.

Dr. Frankland has since reported on this material. Its discovery arose out of the application of Mr. Ransome's method of preserving stone by effecting a deposit of silicate of lime within the substance of absorbent stones:—Mr Ransome saturating the surface with a solution of silicate of soda, and then applying a solution of chloride of calcium, thus producing a rapid double decomposition, leaving an insoluble silicate of lime within the stone, and a soluble chloride of sodium (or common salt), which could afterwards be removed by washing. To prove that by this process a coating of hard silicate of lime was actually formed and deposited, as according to this theory it must be, Mr. Ransome made small blocks of various forms, in moulds, by mixing loose sand with the fluid silicate of soda, and then dipping the mould into the chloride of calcium. To the surprise probably at first of Mr. Ransome himself, but certainly of the chemists of the sub-committee, who performed the experiment in the absence of the inventor, there came out almost instantaneously a perfectly compact, hard, and, to all appearance, a perfectly durable solid. In such solids, at least, there seems to be no element of destruction.

It was evident that such a result could not be without consequences. So far as it bore upon the enquiry of the committee, it is alluded to in their published report. Many considerations connected with the nature and condition of natural stones, liable to destruction by weathering, prevent an absolute decision without much previous experience. Mr. Ransome, however, immediately patented his "concrete stone," and as an artificial stone, it deserves to be well known and thoroughly considered. It promises indeed to combine the advantages, and seems to show none of the disadvantages, of other artificial stones. It is cheap, being made of almost any rubbish on the spot where it is required, by the aid of materials neither costly nor difficult to convey,

It is made with rapidity, and is ready for use without drying or burning. It hardly requires even a temporary shed for the purposes of manufacture, and may be made of any size, and moulded into any form. So far as can be detected, it is subject to no injury from weather, and becomes in fact, if made with sand, a true sand stone, cemented by silicate of lime, than which there is no better natural material. No doubt it will be necessary to watch carefully for a few years the behaviour of the silicate of lime thus deposited, but if it endure that test there can be no doubt that it will then improve by time, increased age only hardening all known silicates of lime, especially those formed from lime used as mortar or cement.

In the application of this subject to the preservation of stone, there seems a probability that some valuable result will follow from the suggestion of Mr. Ransome, to effect the deposit of an insoluble silicate within the pores of an absorbent stone by double decomposition. The objection, strangely felt, that the material thus deposited, would probably be in the form or unconnected grains, rather than a cementing film, seems answered by the formation of a stone so solid as the specimens show; and though it is unlikely that any contrivance can render absolutely permanent a stone that has once advanced far in decay, it will be a great step gained if poor and doubtful stones can be rendered almost indestructible before being placed in a building and exposed to danger.

So far as artificial stone is concerned, Mr. Ransome's material, if it really shows no unexpected weakness, will answer all requirements. It has been tried on a somewhat large scale in the bed of a steam engine, weighing two tons, in the International Exhibition, and again in the new stations recently erected for the Metropolitan Railway. Smaller specimens are very satisfactory. It seems to combine cheapness with durability and resistance to weathering to an extent hitherto unknown.

I append the following results of experiments recently made, and communicated to me by Mr. Ransome:—

The tranverse strength was tested in the following manner:—

	lbs.
A parallel bar of "Ransome's concrete stone," measuring 4in. × 4in., and resting upon iron frames, so as to bear 1in. on the iron at each end, with 16in. clear between the supports, sustained a weight suspended from the centre of	2,122
While a bar of Portland stone of the same dimensions and treated similarly, broke with	759½
The adhesive power was proved upon pieces of stone notched for the purpose; the sectional area of which, at the weakest part, was 5½in.	
The specimen of Ransome's concrete stone sustained... ...	1,980
While Portland stone, of same dimensions, and treated similarly, broke at	1,104
Bath do. do. do.	796
Caen do. do. do.	768

A 4in. cube of Ransome's concrete stone was found to sustain a weight of 30 tons before it was crushed.

The patent concrete stone was afterwards manufactured in the presence of the section by Mr. Ransome. It consists of any kind of mineral fragments, sand, limestone, or clay, mixed into paste with fluid silicate of soda (obtained by digesting flints in a steam boiler under high pressure in alkali), and afterwards dipped into a solution of

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chloride of calcium. The result is an almost immediate hardening of the pasty mass, and the specimens constructed were in a few minutes handed about the room. One specimen, weighing two tons, is in the International Exhibition, while others may be seen in the new façades of the stations of the Metropolitan Railway. These afford sufficient proof of the extent to which the manufacture has already advanced.

Mr. Fairbairn, the President, Dr. Robinson, and other officers of the section, were so much interested in the manufacture, that Mr. Ransome was asked to repeat his experiments at the *soirée* in the evening.

A discussion ensued, chiefly on the subject of preservation of stone, in which Mr. E. Barry and other gentlemen took part.

Mr. Barry said it was premature to say what was the amount of preservative effects of the various solutions that had been tried; more time was required for a thorough test. There was sufficient evidence, however, to show that Mr. Ransome's process had preserved the stone and arrested the decay.

Professor Ansted then explained to the section the result of the labours of the Chemical and Geological Sub-committee, of which he had been a member, in regard to the preservation of the stone of the New Houses of Parliament.

THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY

BY DR. G. S. OHM.

[Continued from p. 305.]

FROM the equation

$$S = \frac{A}{L}$$

we can easily perceive that, when a portion is taken from the galvanic circuit, and is replaced by another, and after this change the sum of the tensions, as well as the energy of the current, still remains perfectly the same, these two parts have the same reduced length, consequently their actual lengths are as the products of their conductibilities and sections. The actual lengths of such parts are, therefore, when they have like sections, as their conductibilities, and when they have like conductibilities as their sections. By the first of these two relations we are enabled to determine the conductibilities of various bodies in a far more advantageous manner than by the previously mentioned process, and it has already been employed by Becquerel and myself for several metals.* The second relation may serve to demonstrate experimentally the independence of the effect on the form of a section, as has previously been done by Davy, and recently by myself.†

In the voltaic pile, the sum of the tensions, and the reduced length of the simple circuit, is repeated as frequently as the number of elements of which it consists expresses. If, therefore, we designate by A the sum of all the tensions in the simple circuit, by L its reduced length, and by n the number of elements in the pile, the magnitude of the current in the closed pile is evidently

$$\frac{n\,A}{n\,L},$$

while in the simple closed circuit it is

$$\frac{A}{L}.$$

If we now introduce into the simple circuit, as well as into the pile, one and the same new part Λ of the reduced length, upon which the current is to act, the magnitude of the current thus altered in the simple circuit will be

$$\frac{A}{L+\Lambda},$$

and in the voltaic pile

$$\frac{n\,A}{n\,L+\Lambda}, \text{ or } \frac{A}{L+\frac{\Lambda}{n}}.$$

It is hence evident that the current is constantly greater in a voltaic pile than in the simple circuit, but it is merely imperceptibly greater so long as Λ is very small in comparison with L; on the contrary, this increase approximates the nearer to n times, the greater Λ becomes to n L, and consequently the more so in comparison with L. Besides this mode of increasing the magnitude of the galvanic current, there is a second one, which consists in shortening the reduced lengths of the simple circuit, which may be effected by increasing its section, or placing several simple circuits by the side of each other, and connecting them in such a way that together they only form one single simple circuit. If we now retain the same signs, so that

$$\frac{A}{L+\Lambda}$$

again denotes the magnitude of the current in one element, then, in the above-mentioned combination of n elements into a single circuit, the magnitude of the current is evidently

$$\frac{A}{\frac{L}{n}+\Lambda}, \text{ or } \frac{n\,A}{L+n\Lambda},$$

which indicates a slight increase in the action of the new combination when Λ is very great in comparison with L; on the contrary, a very powerful one when Λ is very small in comparison with $\frac{L}{n}$, and consequently the more so in comparison with L. It hence follows that the one combination is most active in those cases where the other ceases to be so, and *vice versâ*. If, therefore, we are in possession of a certain number of simple circuits intended to act upon the portion whose reduced length is Λ, much depends on the way in which they are placed, in order to produce the greatest effect of current; whether all be side by side, or all in succession, or whether part be placed by the side of each other, and part in series. It may be mathematically shown that it is most advantageous to form them into a voltaic combination, of so many equal parts, that the square of this number be equal to the quotient $\frac{\Lambda}{L}$. When $\frac{\Lambda}{L}$ is equal to, or smaller than Λ, they had best be arranged by the side of each other, and in succession when $\frac{\Lambda}{L}$ is equal to, or larger than the square of the number of all the elements. We see in this determination the reason why, in most cases, a simple circuit, or at least a voltaic combination of only a few simple circuits, is sufficient to produce the greatest effect. If we bear in mind, that since the quantity of the current is the same at all places of the circuit, its intensity at the various places must be in inverse proportion to the magnitude of the section there situated, and if we grant that the magnetic and chemical effects, as well as the phenomena of light and heat in the circuit, are direct indications of the electrical current, and that their energy is determined by that of the current itself, then a detailed analysis of the current, here indicated merely in outline, will lead to the perfect explanation of the numerous and partially enigmatical anomalies observed in the galvanic circuit, in as far as we are justified in considering the physical nature of the circuit as invariable.* Those great differences which are frequently met with in the statements of various observers, and which are not consequences of the dimensions of their different apparatus, have undoubtedly their origin in the double capability of change of the hydro-circuits, and will therefore cease when this circumstance is taken into consideration on a repetition of the experiments.

The remarkable variability in the circle of action of one and the same multiplier in various circuits, and of different multipliers in the same circuit, is completely explained by the preceding consideration. For if we denote by A the sum of the tensions, and by L the reduced length of any galvanic circuit,

$$\frac{A}{L}$$

expresses the magnitude of its current. If we now imagine a multiplier of n similar convolutions each of the reduced length λ,

$$\frac{A}{L+n\lambda}$$

indicates the magnitude of the current when the multiplier is brought into the circuit as an integral part. Moreover, if we grant, for the sake of simplicity, that each of the n convolutions exerts the same action on the magnetic needle, the action of the multiplier on the magnetic needle is evidently

$$\frac{n\,A}{L+n\lambda},$$

when the action of an exactly similar coil of the circuit, without the multiplier on the needle, is taken as

$$\frac{A}{L}.$$

Hence it follows directly that the action on the magnetic needle is augmented or weakened by the multiplier, according as n L is greater or smaller than $L + n\lambda$, *i.e.*, according as n times the reduced length of the circuit, without the multiplier is greater or smaller than the reduced length of the circuit with the multiplier. Further, a mere glance at the expression by which the action of the multiplier on the needle has been determined, will show that the greatest or smallest action occurs as soon as L may be neglected with reference to $n\lambda$, and is expressed by

$$\frac{A}{\lambda}.$$

* *Bulletin Universel. Physique.* Mai, 1825, and Schweigger's *Jahrbuch*, 1826. Part 2.
† Gilbert's *Annalen*, nn. Folge. Vol. lx. p. 253, and Schweigger's *Jahrbuch*, 1827.

* See Schweigger's *Jahrbuch*, 1826, Part 2, where I have given a somewhat more detailed explanation of the separate points.

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If we compare this extreme action of the multiplier with that which a perfectly similarly constructed convolution of the circuit without the multiplier produces, we perceive that both are in the same ratio to one another as the reduced lengths L and λ, which relation may serve to determine one of the values when the others are known. The expression found for the extreme action of the multiplier shows that it is proportional to the tension of the circuit, and independent of its reduced length; consequently the extreme action of the same multiplier may serve not merely to determine the tensions in various circuits, but it also indicates that the extreme action may be also augmented to the same degree as the sum of the tensions is increased, which may be effected by forming a voltaic combination with several simple circuits. If we represent the actual length of a coil of the multiplier by l, its conductibility by κ, and its section by ω, so that $\lambda = \frac{l}{\kappa \cdot \omega}$, the expression for the extreme action of the multiplier is converted into

$$\kappa \cdot \omega \frac{A}{l},$$

from which it will be seen that the extreme action of two multipliers of different metals, constructed of wire of the same thickness, are in the same ratio to each other as to the conductibilities of these metals, and that the extreme actions of two multipliers formed of wire of the same metal, are in the same proportion to each other as the sections of the wires. All these various peculiarities of the multiplier I have shown to be founded on experience, partly on experiments performed by other persons, and partly on those by myself.* The most recent experiments made on this subject on thermo-circuits, have, in a different, and, in a certain sense, opposite manner, already afforded the conclusion deduced above from an equation of the reduced lengths, that the sum of the tensions in a thermo-circuit is far weaker than in the ordinary hydro-circuits; and a preliminary comparison has convinced me that, with respect to the heating effects, if they are to be predicted with certainty, a voltaic combination of some hundred well-chosen simple thermo-circuits is requisite, and for chemical effects of some energy a far greater apparatus. Experiments, which place this prediction beyond doubt, will afford a new and not unimportant confirmation to the theory here propounded.

(To be continued.)

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1770—FERGUSON, James.—

[An introduction to Electricity in six sections. I. Of Electricity in general. II. A description of the Electrical Machine. III. A description of the apparatus (belonging to the machine) for making Electrical Experiments. IV. How to know if the Machine be in good order for performing the Experiments, and how to put it in order if it be not. V. How to make the Electrical Experiments, and to preserve buildings from damage by lightning. VI. Medical electricity, illustrated with Copper Plates. By James Ferguson, F.R.S.—London: Printed for W. Graham, and T. Cadell, (successor to Mr. Millar,) in the Strand. MDCCLXX.]—8vo., 140 pages, plates.

1771.—EELES, Henry.—

[Philosophical Essays; in several letters to the Royal Society, containing a discovery of the cause of thunder, with a subsequent Explanation and Demonstration of the same. The cause of Ascent, Station, and Descent of Vapours and Exalations: the Cause of Winds; and an Explanation of the general Phenomena of the Weather Barometer, &c. The true Rudiments and theory of Electricity and Magnetism. An attempt to show that the Electrical Powers are the cause of the Reflection and Refraction of light. Some mention of the wonderful Medicinal Effects of Electricity on a great number of Patients, whom the author has cured of Palsies and many other disorders. With other useful matters, which may be deducted from these essays. By Henry Eeles, Esq.—London: Printed for C. Robinson and J, Roberts, No. 25. Paternoster Row, 1771.]—8vo., 189 pages.

* Schweigger's *Jahrbuch*, 1826. Part 2; and 1827.

One edition of this work was published at the same time in Dublin, from the same type except the title page, which is as follows.

[Philosophical essays by Henry Eeles, Esq., containing:—
His Discovery, &c. | An Attempt, &c.
The Cause of, &c. | Some Mention, &c.
The True Rudiments.

Dublin: printed for L. Flin, Bookseller, at the Bible, in Castle Street. 1771.]

1771—SYMES, Richard.—

Fire Analysed; or the several parts of which it is compounded, clearly demonstrated by Experiments; the Teutonic Philosophy proved true by the same Experiments, and the manner and method of making electricity, medicinal and healing, confirmed by a variety of cures: By Richard Symes, Rector of St Werbourgh's Bristol. Bristol: Printed by Thomas Cocking in Small Street, and sold by Robinson and Roberts in Paternoster Row, London; Mrs. Palmer in Bristol, and Mr. Frederick in Bath. MDCCLXXI.]—Pam.

1773—BECKET, J. B.—

[An essay on Electricity, containing a Series of Experiments, introductory to the Study of that Science; in which are included some of the latest Discoveries, intended chiefly with a view of facilitating its application and extending its utility in Medical Purposes. Bristol; Printed for J. B. Becket opposite the Exchange, Bristol; sold by T. Becket in the Strand, and G. Robinson in Paternoster Row, London; D. Prince at Oxford; W. Frederick at Bath; and E. Score and B. Thorn at Exeter. MDCCLXXIII.]

1773—NAIRNE, Edward.—

[Directions for using the Electrical Machine, as made by Edward Nairne, Optical Philosophical and Mathematical Instrument Maker, Fronting the Royal Exchange, Cornhill, London; Printed in the year MDCCLXXIII.] Pamphlet. Plate.

1773—JOSE', Sebastia.—

[Noticias Historicas, e Practicas Acerca do Modo de defender os edificios Dos Estragos Dos Raios Compilardas pelo Douter Joaõ Antonia Dalla Bella Lente de Filosofia Experimentalna Universidade de Coimbra, e Offerecidas Aoill^mo e Exc^mo Senhor Sebastiao José de Carvalho, e Mello, Marquez de Pombal Ministro, Secretario de Estado, de sua Magestada Fidelessima sew Lugar-Tenante na fundacam da mesma Universedde de Coimbra le le Lisboa na Regia Officana Typografica, Anno de MDCCLXXIII. Com licença da real Meza Cenferia.]—Pam., Plate.

1773—WILSON, B.—

[Observations upon Lightning and the method of securing buildings from its effects, in a Letter to Sir Charles Frederich, &c., &c., &c. By B. Wilson, F.R.S., and Ac. Reg. Up. Soc., and others. London; printed for Lockyer Davis, Printer to the Royal Society, opposite Gray's Inn Gate, Holborn, MDCCLXXIII.] 8vo., 68 pages.

1774—FRANKLIN, Benjamin,—

[Experiments and Observations on Electricity made at Philadelphy in America, By Benjamin Franklin, L.L.D. and F.R.S., &c. To which are added Letters and Papers on Philosophical Subjects. The whole corrected, methodized, improved, and now collected into one volume, and illustrated with Copper Plates. The Fifth Edition London: Printed for F. Newbery at the Corner of St Paul's Church-yard, MDCCLXXIV.] 4to., 514 pages. Plates.

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1775—Priestly, Joseph.—

[The History and Present State of Electricity, with original experiments, by Joseph Priestly, LL.D., F.R.S. The fourth edition, corrected and enlarged.—London: printed for C. Bathurst and L. Lowndes, in Fleet-street; J. Rivington and J. Johnson, in St. Paul's Church-yard. &c. &c., MDCCLXXV.]—4to., 700 pages, with plates, &c.

(?) 1775—Roberts, G.—

[Pinnock's Catechism. A Catechism of Electricity, being a short introduction to that science; written in easy and familiar language. Intended for the use of young people. By G. Roberts. Second edition.—London: printed for Pinnoch and Maunder, *Mentorian Press*, 267, Strand; by C. Green, 15, Leicester Street, Leicester Square.—12mo., 71 pages, cuts, no date.

1775—Beccaria, Ciambalista—

[Della Elettricità terrestre atmosferico a cielo sereno osservazioni De Giambalista Beccaria, delle scuole pie dedicate a sua altessa Reale il Signor Principe di Premonte.]—4to., 53 pages.

No date on title, consists of letters, dated 1775.

1777—Strong, Adam.—

[The Electrical eel, or Gymnotus Electricus, inscribed to the Honourable Members of the R***l S*****y, by Adam Strong, Naturalist.—London: printed for J Bew, in Paternoster Row, MDCCLXXVII.]—4to., 19 pages..

1779—Adams, George.—

[An Essay on Electricity, explaining the principles of that useful science; and describing the instruments, contrived either to illustrate the theory, or render the practice entertaining. Illustrated with six plates; to which is added a letter to the author, from Mr. John Birch Gurgeon, on the subject of Medical Electricity. By the late George Adams, mathematical instrument maker to His Majesty, &c. The fifth edition, with corrections and additions, by William Jones, mathematical instrument maker.—London: printed by J. Dillon and Co., for, and sold by, W. and S. Jones, opticians, Holborn, 1799.]—8vo., 594 pages, plates.

REPORT ON THE DEEP SEA SOUNDINGS TO THE WESTWARD OF IRELAND.

Made in H.M.S. "Porcupine," in June, July, and August, 1862.

Belfast, September 30th, 1862.

Sir,—The Atlantic Submarine Telegraph Company have requested the Lords Commissioners of the Admiralty, to have some deep soundings taken off the western coast of Ireland, principally to ascertain whether the apparent sudden dip in the soundings from 550 to 1,750 fathoms, found by Commander Dayman in the year 1857, in the parallel of 52° 15′ N., extends further north or south, and to endeavour to seek out a more gradual slope into the bed of the ocean, their lordships were pleased to direct that the *Porcupine*, then fitting at Devonport, for the survey of the North Sea, should be despatched on this service.

The *Porcupine* is a paddle steamer of 130 horse power, and 380 tons. She was manned by a crew of forty-nine officers and men, and was fitted with a donkey engine for heaving in the line; also with five light iron reels, three large for the deep sea line, and two small for cod line, capable of holding 2,000 fathoms of line each. From these reels the line was run off when sounding, and reeled on them by hand, as it was hove in by the donkey engine. The *Porcupine* was also supplied, at Devonport, with 10,000 fathoms of the ordinary deep sea line, and 13,000 fathoms of cod line, made expressly for deep sea sounding, with an ample supply of sinkers and weights, and the bulldog and other apparatus for bringing up the bottom; Johnson's and Hearder's pressure guages to show the depth were also supplied, as well as metallic and ordinary deep sea thermometers to test the temperature. At Galway a further supply of 10,000 fathoms of Messrs. Newall's cod line was received on board, besides 11,500 fathoms of a smaller and less expensive line. The weight per 1,000 fathoms, with the breaking strain of these sounding lines, was as follows:—

Lines.	Fathoms.	Weight.	Breaking Strain.	
		lbs.	Cwt.	lbs.
Ordinary deep sea	1000	230	6	63
Newall's cod	1000	56	3	14
Laid twine	1000	17½	0	100?
Marline	1000	29	0	100?
Mackerel	1000	26	0	100?

The lines were marked in the usual way, viz., blue at 50 fathoms, white at 100 fathoms, and red at 1,000 fathoms.

The soundings were always taken from the bow of the vesssel. With the main and mizen sheets out we had no difficulty in keeping her head to wind; and an occasional easy turn ahead sufficed to keep her bow directly over the descending lead.

The principle of using a small line and heavy weight for obtaining the depth was that adopted. I believe it to be the only means at present known for obtaining the true depth.

When using a heavy line, such as the ordinary deep sea line, the difference of interval, after the weight strikes the bottom, is not sufficiently marked to enable one to say, confidently, when it is down, particularly should there be any sea, and none of the instruments we were supplied with, whether of a rotatory character, like Walker's, or those depending on compression, as Johnson's and Hearder's pressure guages, give any results that can be at all relied on.

The cod line supplied by Messrs. Newall, of Gateshead, is an admirable line for this purpose. The weight was sometimes brought up by it from great depths. On one occasion it raised a 64 lb. weight, from a depth of 1,750 fathoms; but as the whole quantity out is frequently sacrificed at each sounding, the expense becomes a serious consideration when the soundings are required near each other; and I found the lighter and much less expensive lines answer equally well in smooth water, where the depth of water alone was required.

The strongest line we had for bringing up a specimen of the bottom, with the instruments for testing the temperature and pressure, was the ordinary deep sea line. If, as it sometimes happens, the weight does not detach itself, this line would prove unequal to the strain, and, at some sudden heave of the sea, would break away, losing all our instruments.

The simplicity, cheapness, and certainty of action of the cup lead, of from 56 lbs. to 75 lbs. weight, renders it an invaluable instrument in depths under a thousand fathoms, bringing up a good wine glass full of the bottom at each cast. It may be used either with the cod or ordinary deep sea line. In greater depths, when a specimen of the bottom was required, we used the bulldog machine.

To save time, the two operations of determining the depth by a small line, and sending down the instruments for scientific purposes, were carried out together, an officer being stationed at each line to time the marks in their passage over the gunwale. A deep sounding, when the instruments were to be recovered, would occupy from two to four hours.

Having made these preliminary observations, I may now proceed with the progress of the voyage.

Having swung ship for compass deviation, I sailed from Plymouth Sound on the 22nd of June, and on the 24th commenced our examinations, in pursuance of your orders, at the 100 fathoms line on the 51st parallel of latitude. The deep water valley crossed by Commander Dayman ninety miles west of Valentia, was found to extend to this parallel, as we had 1,180 fathoms in its deepest part, and 375 fathoms on the bank outside it. From the depth of 1000 fathoms in this depression, the bulldog machine brought up a bivalve shell embedded in the soft clay.

On crossing the bank to the westward, we passed from a depth of 710 fathoms to 1,550 fathoms in a distance of seven miles. Although this increase of depth seems so great, if the incline is gradual, of which we have no evidence to the contrary, it amounts to but 12 feet of dip in 100 feet horizontal, or about 1 in 8.

To the westward of this we dropped our lead on the position of a reported vigia (the Brazil Rock) and obtained 2,350 fathoms, and

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here the deep sea line being unequal to the strain, broke, taking with it all our instruments attached.

With reference to this and other vigias in this part of the ocean, I may observe, that we frequently passed balks of timber, covered with barnacles and sea weed, having somewhat the appearance of a rock awash.

(To be concluded in our next.)

THE FAMILY OF THE LATE MR. SUTER.

THE following is a list of the sums which have hitherto been received on behalf of the widow and family of Mr. Suter:—

	£	s.	d.
Messrs. Bright and Clark	10	0	0
J. C, Laws, Esq.	5	0	0
Capt. Long, "S. S. Sir James Duke"...	5	0	0
J. E. Woods, Esq.	5	0	0
J. Alexander, Esq.	5	0	0
Dr. Higgs, Aden	5	0	0
Owen Rowland, Esq.	1	1	0
Thomas Whiltering, Esq., Greenwich	0	10	0
Benjamin Bacon. Esq., Greenwich	0	10	0
J. Bishop, Esq., Greenwich	0	10	0

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d. per lb.
Negro	1s. 2d. to 1s. 4d.
Java	1s. 6d. "

GUTTA PERCHA

Fine	2s. 4d. to 0s. 0d. per lb.
Genuine Mixed	1s. 9d. to 2s. 0d. "
Ordinary Reboiled	1s. 0d. "

Both articles in demand, and likely to be higher in price owing to the Home and Export orders.

November 6, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	———
20	Do. B 7 per cent. till 1862 .	—	———	———
Stock	Electric Telegraph . .	100	100 to 103	101¾
25	Do. New	20	———	———
5	London District Telegraph .	4½	4 to 3 dis.	———
4	Lond. & S. Ireld. Direct Tel.	all	———	———
10	Mediterranean Extension Tel.	all	3 to 4	———
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ½	———
1	Do. registered . . .	all	⅜ to ½	———
10	Do. " . . .	all	4 to 6	———
2	Telegraph to India . .	1	¾ to ½ dis.	———
5	United Kingdom Telegraph .	3	½ dis. to par.	———

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—Having recently been trying some experiments, with a view to the production of the "lime light" on a small scale, you will not perhaps be surprised to learn that, like those of many other amateurs, my efforts were crowned by an explosion, which, though not of a very serious nature, considerably cooled down my ardour for mixing, and producing combustion of the mixed gases, and, I may here remark that this accident occurred, although my apparatus was guarded by a modification of "Hemmings's safety jet," discs of wire gauze, taking the place of his bundle of wires, the whole constructed in accordance with the description given in "Noad's Chemistry."

My object in writing to you now sir, is not merely to detail simple failures, but to enquire if you can give me any explanation why an *explosion* should take place at all.

I can readily understand such a phenomenon attending the combustion of a solid, such as gunpowder, where the resulting gases, of vastly increased volume, are made for an instant to occupy the same space as the original solid, but I cannot divest myself of the idea, that, precisely the opposite effect should be produced when two gases are as instantaneously condensed into an equally diminished volume. With the eudiometer, when made strong enough to bear the shock, the residuum is a very small quantity of water, what then gives the force tending to disintegrate the instrument? In the experiment referred to, my "Sprightly" haplessly neglected to apply the proper amount of pressure to the bladder containing the precious mixture, in an instant there was a noise like a clap of thunder, "Sprightly" was thrown back in convulsions, the bladder torn in ribbons, the apparatus in ruins, with the table cleanly swept of all its contents, while a globe of flame swept toward the fireplace and vanished up the chimney, immediately afterwards clothing me, "Sprightly," and the apartment, in a perfect soot of black.

Trusting you will oblige by giving your opinion upon this, to me, paradoxical point, why a sudden diminution of bulk should cause such an extremely increased pressure upon the retaining vessel?—I beg to remain, yours, respectfully, K. R. U.

[The question, as stated, unnecessarily involves the paradox you refer to. The condensation of the gases is immediately preceded by an enormous expansive force, exerted during an infinitely small period of time and consequent upon the liberation of caloric previously existing in a latent form. The safest plan to perform similar experiments, is to attach a blowpipe to a bladder of *oxygen*, and with it to direct a flame of hydrogen upon the article to be ignited.—ED. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Previous to coming up to town, I had heard what eminent business men Londoners were, the city gentlemen in particular, and I must say that a short experience of two years, has not belied a report which has passed into a proverb down in our benighted district. I will now stay to enquire how much of this eminence is due to a species of commodity which obtains very much up in this quarter, and which may be expressed by a variety of words, whose first letter shall begin with a big B. No, I will just content myself by saying that those awfully expressive adjectives, "sharp," "screwed," "eminent," &c., as applied to the class above mentioned, simply mean a surpassing devotion to the interests of the first person, nominative, singular, or plural, as the case may be; and it is surprising how much this number one element peeps out in all the transactions of daily life in this modern Babylon, not but what the same may be said of every place the world over, but here it is so transparent, there is no attempt at concealment, and, indeed, why should there be, since this is what may be termed the superscription which is held as a proof that the metal is genuine. This is eminently characteristic of a communication which has been sent the round of the press by Messrs. Glass, Elliott, and Co.; but it partakes more of the character of an advertisement than an ordinary communication, and, therefore, invites our attention, and also, if occasion requires, our criticisms.

How fortunate it is for the next generation, and, perhaps, for ought we know, the tag end of this, that every one feels so confident that "a good and durable cable" may be laid between here and America. We all believe it, and, therefore, are by no means surprised that cable manufacturers also should give utterance to the same sentiments, because, if all the world beside were to say "No," these must perforce say "Yes," as per natural sequence.

Well, Messrs. Glass, Elliott, and Co being convinced of its practicability, will, as a matter of course, be very happy not only to make the cable, but lay it in one unbroken length from Ireland to Newfoundland, on certain conditions.

Suppose we examine these conditions: the first runs thus, "That we shall be paid each week our actual disbursements for labour and material." This condition has, at least, one recommendation, it is plainly spoken and unmistakeable. But it is such I fancy, that no company, however wealthy, would fall in with, unless counterbalanced by some very manifest advantage. But this, in contradistinction to most other commercial undertakings offers no such advantages which those who go upon the ready money principle are justified in expecting. It is a work which must be done well, and as in most cases the ready cash from week to week, as the work proceeds, is a stimulus to renewed exertion and excellence, in this particular case, the reverse would be the result, as past experience but too well testifies. Generally, in the ordinary undertakings of manufacturing firms, there is sufficient work done, and sufficiently complete in itself, at stated times, for those interested therein to judge as to whether it be completed in conformity with the contract. But this is manifestly impossible in the manufacture of a submarine cable, and if the contract bind the manufacturer to the submersion of it also, it is self-evident that by paying from week to week for the work done, is simply, to use a vulgar expression, "to buy a pig in a bag." Your readers will pretty well understand how this is, without any further explanation. The success of 2000 miles of submarine cable, is an affair that cannot wisely be submitted to the workings of such a condition, as this one under consideration, and it is made from such a purely selfish point of view, that we cannot but feel annoyed at the flagrant obtrusion of number one. I was just on the point of cataloguing the inestimable benefits I should be able to bestow upon mankind with the ad-

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vantage of such a condition as the one above named, in my favour. But I forbear, suffice it to say that the catalogue of the British Museum would be completed before doomsday, London streets would be kept free from mud, &c., &c., &c. In fact, what could not an enterprising man of no capital do with this condition as the basis of his bargain.

The "condition," says the "*actual* disbursements for labour and material." But do you for one moment suppose that any man would not add a tolerable per centage of profit thereto? The very character of the proposition is a guarantee that he would. The first "condition" being so neatly done, of course we are by no means surprised to find the second composed of the same element, double distilled. "Twenty per cent on the actual cost of the cable, in shares of the company," is such an absurdly small profit; why was it not made fifty per cent? Is it supposed that an Atlantic cable will ever pay? Surely disinterested zeal should be duly rewarded, and its interests secured in such a contingency.

Now, I am not one of those who think it an absurd impossibility to lay a cable successfully from Ireland to Newfoundland, although I am disposed to think the Northern route preferable, and subject to the least risk. But candidly, I should be extremely sorry to risk one share even, in such a cable as that proposed some months ago, by Messrs. Glass, Elliott, and Co, to the Atlantic Telegraph Company. A heavy iron sheathed cable, 2000 miles long will never do, and can never be successfully laid; it has hitherto been the curse of deep sea telegraphy, and has tended more to retard its progress than any other cause, with the exception perhaps, of those concomitants of monopoly, inexperience, jobbery, and peculation. This is the view supported and maintained by all nautical men who have paid any attention to the subject, and whose opinion is worth anything, indeed one is necessarily impressed with the unanimity which exists among seamen upon this matter, proofs of which are of weekly occurrence, and truly, if telegraph engineers, and telegraph companies were wise, the results of a matured experience from so satisfactory a quarter, would no longer be ignored as they have been.

A cable of a light specific gravity, such as have been so often described in your Journal, could, doubtless, be laid in one unbroken length 2000 miles, with little or no risk, if past experience has been of any service to us; and for a third of the cost of the ponderous cables, which a mistaken notion deems essential. We read of light cables which are as perfect at every point as any reasonable man can expect a cable to be, capable of bearing their own weight for some 10,000 or more fathoms; and the question naturally forces itself upon us, why is not a trial given to each of these, that the public may thereby be able to judge whether they have any points of excellence or not. If superior to their ponderous precursors, wherefore waste capital, and chain the wheels of telegraphic progress, by an obstinate and infatuated adherence to that which common sense, and past experience condemns.

One of the strangest things of the present day, is the absence from the field of telegraphic enterprise, of some pushing and wealthy joint-stock company, capable of tendering for, and executing any length of submarine cables, manufactured on principles in conformity with the growing experience on the subject. Far be it from me to indulge in any remarks of an invidious nature, but as one of the million, I simply echo the sentiments of the public, a sentiment which receives confirmation daily in a thousand ways, that monopoly is inimical to progress; and that so long as there is only one party in the field capable of undertaking contracts of any magnitude, so long shall we go on blundering, and becoming the victims of our own mistakes.

Truly, the field is wide, and the labourers could not well be fewer; here is a harvest of gold to be gathered, which might dazzle the eyes of the most inveterate of Mammon's devotees. Fancy the enormous dividends the shareholders of the Atlantic Telegraph Company would have been receiving now, and for the past eighteen months, had their cable been in working existence! And, without a work of mutual slaughter, to give a stimulus to the use of a cable, the commercial relations between the old and new worlds are sufficient, in themselves, to support two or three cables at paying points; and it is only confidence that requires to be restored, by the submitting of the enterprise to wholesome competition, in order to facilitate a consummation so ardently desired by the people on both shores of the Atlantic. Telegraph companies, however, to carry out this great desideratum, whether in a direct line, or by way of the north, or any other route, are literally useless, unless manufacturing companies spring up simultaneously, for the purpose of making the cables required, on principles dictated by common sense, and common experience.

ONE OF THE MILLION.

To the Editor of THE ELECTRICIAN.

SIR,—I am deeply grieved to see that your second volume closes almost in its last words, with the details of a lamentable accident, through the fall of an aërial wire. I sincerely hope that no similar accident may have to be recorded in your pages in any future volume, and for the sake of electric, and other applied sciences, I hope that your able efforts to render them interesting to the scientific and general public will meet with such encouragement as to render the existence of such a paper indispensable to the scientific world, as long as humanity can derive benefit from its development; or, at least, till Lord Macaulay's New Zealander takes a sketch of Paternoster Row in ruins, amongst the other interesting objects in this vast wilderness of bricks and mortar, "from a broken pier of London Bridge."

I little imagined, when I ventured a joke upon the subject of a modern Laocoon, in the shape of a Paterfamilias enveloped in the coils of an aërial telegraphic wire (as I did in a former number), that I should so shortly afterwards hear of a fatal accident from such a cause. I deemed it almost impossible, at least in the earlier stages of these constructions, that they should not be so thoroughly proved and tested, in what appears to me the simplest and most inexpensive manner, with the means at the command of modern engineering, as to render such an accident impossible. I confess I had misgivings as to the safety of these constructions, after any length of years, because I felt that rust and other atmospheric influences might, possibly, so insiduously undermine the tenacity and durability of the structure, that any weak places, or flaws, in the material must, of necessity, escape detection, from the difficulty there must always be in inspecting material necessarily so far removed from daily examination.

I suppose, that no other plan for carrying the wires from place to place can be adopted with any regard to the success of an undertaking which, I must confess, affords very great conveniences to the public, both as regards the rapidity, as well as the economy, of the communication, in exemplification of which I personally have experienced great advantage from it this very day. I was in Sloane Square, Chelsea, and was very anxious to send a short message into the City, east of Moorgate Street: for the trifling charge of sixpence, I was enabled to have my wish executed in less time than I could possibly have sent a messenger in a cab to carry them out, and much quicker, and at half the price, that an omnibus traveller could have done it for, there and back again; not taking into account the value of the messenger's time. I am bound to say, that I was quickly and satisfactorily attended to by one of those young people whose employment in this occupation I have so strongly urged,—whether rightly or wrongly, may be an open question between your correspondent, "*Tot homines tot sententia*," and myself, and if the managers of the District Telegraph Company always make their selections of *employées* with the same good judgment, the flippant description in your correspondent's letter is not justified in their case, whatever it may be in the case of any other companies who are employers of female clerks as manipulators.

I cannot understand what excuse can be put forward to account for the fracture of an aërial telegraphic wire, the strain upon which, I should imagine, could be calculated to within a few pounds of the greatest pressure that the wind could at any time exercise upon it, combined with atmospheric or other changes of temperature, which are, I should suppose, well known in their effects upon a given length of wire of certain dimensions.

I can only suggest my fears, that a shortsighted economy may have induced the managers of this department of the company's service, to allow an inferior description of telegraphic wire to be used in this place. Those least initiated in the manufacture of iron, know that there is a great difference in the tenacity and strength of different modes of preparation of the iron; and that it does not of necessity follow, that every piece of iron of exactly the same proportions of thickness or length, must be of precisely the same strength. These days of "great exhibitions" would have passed fruitlessly, indeed, if such common-place knowledge was wanting upon this subject, and I should be glad to see that the London District Telegraph Company could conscientiously publish a statement that they had purchased and paid for the very best description of iron telegraph wire, and that they would, in exculpation of themselves, state the price they had paid, and the manufacturer's name who had produced the defective wire.

It is no light matter, as some men of practical science would make us believe, that even one man's life should become a sacrifice to the convenience and comforts of his neighbours. I hold life to be that mystical sacred link which no human means can create, and no earthly power can reform when once broken, and any man who either directly or indirectly is the means of destroying this most precious gift of God, must not be held guiltless in the eyes of his fellow man; true it is, that not a sparrow falleth to the ground without the knowledge and permission of the Most High, but no false pleadings of fatalism, no specious sophistry of predestination must blind the eyes of the community to the fact that *we are each one "his brother's keeper."* "It must needs be that offences come, but woe to that one by whom the offence cometh."

Your correspondent, "Citizen," in the number of the 17th October, throws out some hints as to the difficulties that beset purely commercial undertakings of this kind when he suggests the need of some company who could feel itself free "to insure without doubt the best materials being used, the best mechanical construction being applied, and the greatest care being taken in all parts of each undertaking," and very properly finishes by saying, "the sooner monopoly, self interest, and self-elected importance is abolished, the nearer we shall be to success in all the branches of this most important science."

If, however, such accidents are to be considered as such and beyond human control, then I really, on behalf of the public safety, must beg to call the attention of the municipal and parochial authorities to the subject, and beg of them to lose no time in seeing that some method is adopted to render their occurrence less likely, and less disastrous upon their recurrence; as by avoiding the densest thoroughfares as much as possible the

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proportionate risks may be very much reduced, and greater confidence may be given to the perambulating public at large.

The surveyors of the highways should make this matter part of their daily duty.

Hoping that I have not trespassed too much on your valuable space, I am, sir, yours obediently, Philanthropos.

ON THE CONDUCTION OF THE ATMOSPHERE.

To the Editor of The Electrician.

Sir.—In your last number Mr. Latimer Clark has called the attention of practical telegraphists, to the above important subject. As a witness of the experiments referred to by him, I may be allowed to make a few observations upon the subject. I agree with Mr. Clark as to the result of those tests, but at the same time, I have some doubts as to the manner in which they were conducted. The experiments were performed in a *hurry*; experimental tests require a vast deal of patience and care, especially when electricity of high tension is employed; for instance, I found that the arrangements of the scientific committee of the Government Telegraph Commission were perfectly useless, and I had to reconstruct and re-arrange the whole machinery, before any reliable results could be obtained in testing the various insulated cores supplied for that purpose by their respective manufacturers; however, I will now give in detail, the result of my experiments upon two lengths of one mile each of aerial insulated copper wire. The wire, was not *coated* with any insulating material, but merely insulated upon porcelain, inverts and terminals, the distance between the terminal posts being 220 yards or one-sixteenth of a mile, with an intermediate support It is hardly necessary for me to state, that having the authority of the Board of Trade, I had no difficulty in procuring the most efficient insulators then known. I endeavoured to obtain the very best insulators and upon the two miles of insulated wires, I made some thousands of experiments.

In the first place, I will describe the battery employed, it consisted of 512 elements of Muirhead's improved Daniells. The troughs were well insulated, being suspended to the ceiling of the room, by means of gutta percha straps.

The instrument employed, was the galvanometer, described by Mr. Clark as having 30,500 turns of wire.

On a given day I had one pole of this powerful battery connected with earth, and the other pole, through the galvanometer, connected with the end of one mile of the copper aerial wire, the other being insulated; there was no loss of insulation or leakage upon that mile. The needle of the galvanometer remained at zero; however, as I watched the needle, I found that now and then it suddenly deflected, exhibiting what is generally called a *loss of insulation*, but what should be called in order to render it intelligible, *leakage*. This very much puzzled me at first. In order to ascertain the cause of these sudden deflections, I requested one of my assistants to watch the wires, and see that nothing came in contact with them, as I was engaged in making my observations A sudden deflection having taken place I called out to the "Watchman," "Something *touches* the wire." "No," said he, "the steam from the railway engine has just past over it, and that may have had some effect." (The distance between the locomotive and the wires, was about thirty yards.) The discovery of the fact, led to a series of experiments. I had all the insulators supporting one mile of wire, thoroughly cleaned, and the internal part coated with a viscid matter (Hughes's fluid); upon testing the mile for insulation, I found it perfect. No loss whatever. The other mile, running parallel, but at a distance of about eighteen inches, was connected with earth. The two miles of wire had no metallic contact, in fact, they were perfectly independent of each other, but when the column of steam passed over both wires, the one in connection with the galvanometer instantly gave a deflection, indicating a loss of insulation. A portion of the electricity with which one mile was charged, must have passed with the steam to the other mile in connection with earth, or must have been conducted by the means of the steam, to the locomotive itself, which was, as in the case of the mile of wire, in contact with earth. The experiments were repeated in each case, with precisely the same results. A column of smoke had also the same effect. I made also numerous experiments, to ascertain the effect of moisture upon the surface conduction of the insulators. The surface conduction, and the inductive absorption of an insulator are very different. The latter affects the transmission of the current in dry, as well as wet weather. This is a subject to be referred to hereafter.

Let English and French telegraphists investigate the causes which deprive them of the fair and full advantage of the electro-motive force, employed in the operation of telegraphy. In England, our telegraphic lines mostly follow the track of the locomotive, in France they follow the imperial highways.

I shall defer some further observations on this subject until next week,

Owen Rowland.

(To be continued.)

Telegraphic News.

We extract the following from the "City Article" of the *Times* of Monday last. "The *Manchester Guardian* states, on what it considers to be most respectable authority, that a wonderful discovery has recently been made in electricity as applicable to the purposes of the electric telegraph. 'Incredible as it may seem, it is said that experiments have established the fact that intelligible signals can be exchanged between distant stations without the intervention of any artificial conductor whatever, and with equal success, whether the intervening space be wholly or partially land or water.'" If the "distant stations" in question, be but a few hundred yards apart—and we do not apprehend that experiments have been made between points more widely separated—the fact is not very wonderful on the score of its novelty. Experiments, some of which were performed at the Government expense, have long since shown that "the earth" may be employed as the sole conductor in transmitting an electric signal across a body of water, &c., though not with any possible advantage in a practical point of view.

A Feat in Reporting.—Most of our readers will have perused the recent speech of Mr. Cobden at Rochdale, very few, however, are aware of the means taken by the metropolitan press to ensure a full report of that speech. They were as follows: A staff of reporters, despatched from London on Wednesday morning, duly took up their stations at the place of meeting at the appointed hour. At ten minutes to eight o'clock Mr. Cobden rose, and continued speaking till ten minutes to ten, every word he uttered being taken down in short-hand. The reporters, having finished this part of their duty, made all speed to the Rochdale station, caught the last train, and were whirled to Manchester, meanwhile taking advantage of the time to transcribe a portion in the railway carriage. This journey was rendered necessary by the fact that there is no direct communication to London from Rochdale. It was hard upon eleven o'clock before they reached the Manchester offices of the United Kingdom Telegraphic Company. Reporters and telegraphers then set to work, the company having pressed three of their wires into service, and by three o'clock yesterday morning the entire speech was delivered at the office of *The Daily Telegraph*, and an hour afterwards it was being struck off at the rate of upwards of forty thousand copies an hour. Thus, with the energetic co-operation of the United Kingdom Telegraphic Company, they were able to publish, shortly after four o'clock in the morning a *verbatim* report of a two hours' oration delivered more than 160 miles from London at a late period of the preceding night.

We learn that a new signalling instrument is under trial upon some of the telegraph lines in Spain, and is very highly approved of by the *Direccion de Telegrafos* at Madrid, being considered less complicated and more rapid than any of the instruments hitherto tried. In a communication we have received from the Spanish Telegraph authorities, it is even compared favourably with the instrument of Professor Hughes, the admirable performance of which we have latterly had occasion to witness. Like the latter, its extreme sensibility renders the employment of a local battery unnecessary, and it possesses, moreover, the novel feature of giving a double copy of the dispatch. We are promised further details respecting the new system.

Miscellanea.

Lightning Conductors.—The recent experiments of M. Perrot show that, where large masses of iron are employed in the construction of buildings, it is necessary that lightning conductors should be applied upon new principles. The main results of these experiments may simply be summed up in the statement, that whenever a mass of metal in contact with, or in proximity to the conductor at one point, becomes charged, either from the latter or from the atmosphere, the preservative action of the lightning rod is no longer sufficient to obviate the effects of disruptive charge. Such masses of metal require to be connected to earth at two opposite points, so that what the telegraphist would term the "discharge of derivation," as well as the main discharge, should obtain a metallic path to earth. M. Perrot finds that, by arming the upper extremity of the *paratonnère* with a crown of points, its neutralizing influence is rendered far more efficacious, and that by arming the rod from the summit to the base with a number of lateral points, it is protected from lateral discharge.

To Correspondents.

T. P.—In regard to the durability of hemp in sea water, we have recently examined some specimens of the Red Sea cable, in which the hemp was in a very perfect state of preservation. Hemp, in conjunction with steel wires, was strongly recommended for the external covering of submarine cables by the late Mr. Robert Stephenson; and the cable from France to Algiers, which has been submerged during a period of two years, offers some proof of its adaptability for this purpose. Several miles of this cable were, on more than one occasion, recovered in deep water, repaired, and relaid with perfect success.

F. R.—Mr. Owen Rowland, who erected the first overhouse telegraphs in England, for Messrs. Waterlow and Son, and for Her Majesty's printers, made numerous experiments, in 1858, at the Hackney marshes, to test the tensile strength of steel and iron wires, and also the effect of sulphurous acid upon such wires in cities. He employed the best tough steel wires, protected with a coating of paint peculiarly adapted for the purpose.

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The Electrician.

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THE CHEMICAL THEORY OF THE VOLTAIC COUPLE.

[Continued from page 2.]

Nitric Acid Batteries.

THE fallacy of the commonly received explanation of the difference of power in the various forms of battery is specially evident in the case of nitric acid batteries. Although nitric acid is known to be far more readily decomposable as an electrolyte than the protoxide of hydrogen (water), the latter is supposed to be the electrolytic conductor, and its hydrogen, liberated at the surface of the negative element, is supposed to be oxidised by the nitric acid, giving rise to a negative force, diminishing, to some extent, the force of the battery. Very little consideration suffices, in this instance, to show that such a negative force cannot exist. In electrolysis, we may always trace the effect originated at the surface of the positive element, in a chain of electrolytic decompositions and recompositions, to the surface of the negative element. Now in the nitric acid battery, the secondary or negative reaction is held to be originated through the oxidation of hydrogen by nitric acid; and we have to trace an electrolytic effect from the surface of the platinum, or charcoal, to the surface of the zinc. But, assuming that hydrogen is oxidised at the surface of the negative element, the action is obviously merely local, since two equivalents of oxygen are thus subtracted from nitric acid (NO_5), and nitrous acid (NO_3) is evolved, without being electrolytically transmitted in the direction of the zinc element.

According to our view, the action of nitric acid batteries is shown by the chemical formula:—

$$\underbrace{-\overset{+}{N}O_3\,2\overset{-}{O}.}_{\text{Nitric acid.}} + \underbrace{2\overset{+}{H},\,2\overset{-}{O}+}_{\text{2 Water.}}$$

and the decomposition of nitric acid takes place electrolytically, in the following manner:—The zinc, represented by the right hand +, combines with oxygen from the water, rendered easily decomposable by the addition of sulphuric acid. Two equivalents of the metal thus nnite with two equivalents of oxygen, the hydrogen of the two decomposed molecules of water decomposing the contiguous polarized molecules, and this action being continued to the surface of junction of the water and the nitric acid. Here 2H combine with 2O from the nitric acid, and a similar electrolytic recomposition and decomposition occurs to the surface of the negative element where NO_3 is evolved.

The very remarkable power of the nitric acid couples of GROVE and BUNSEN, in comparison with the couples of VOLTA and of DANIELL, is sufficiently accounted for by the presence, as voltaic elements or electrodes, of bodies which, from their strongly opposite electro chemical character in relation to each other, are capable of maintaining a very high intensity of polarisation in the fluid, and consequent tension at the poles; and, also, by the very slight degree of resistance to electrolysis in the nitric acid, increasing the quantity effects in these combinations. It is not generally known that couples constructed on the model of that of DANIELL, with silver or platinum as the negative element, and a salt of silver or platinum in solution as the exciting fluid for the negative, are almost, if not quite, equal to those above mentioned, both in regard to tension and quantity. The question of expense must operate against the general employment of batteries constituted with salts, as well as negative plates, of the noble metals; but in the laboratory the objection does not so strongly apply, the percentage of waste being inconsiderable when due care is exercised, and the actual consumption being merely in the negative constituent of the salts in question. The combinations to which we refer are obviously free from the objections which apply to nitric acid batteries, viz., the employment of a powerfully corrosive fluid, and the evolution of nitrous fumes.

The voltaic arrangement latterly adopted by M. GRENET is worthy of careful study from an electro-chemical point of view; and the elucidation of the points to which we have principally referred, must contribute to throw some light upon the peculiar conditions involved in its action. We by no means consider, however, that this form of battery constitutes perfection in the application of the principles of electrolytic polarisation and conduction. As our readers are already aware, the main features in the couple of M. GRENET are, 1st, the employment of an exciting fluid, composed of dilute sulphuric acid and bichromate of potash, an oxidising agent, in solution; and, 2nd, the passage of atmospheric air through the fluid. Thus the zinc element becomes oxidised under the joint action of water, the salt of chromic acid, and atmospheric oxygen. Both water and the salt are electrolysed, and contribute to the effect of conduction. As, in all cases where water is decomposed in the battery, the negative element is liable to polarisation, and thus to occasion a secondary reaction opposed to the main voltaic effect; but the hydrogen liberated at the surface of this element, is instantly removed by oxidation, produced by the bichromate solution and by atmospheric oxygen conjointly. However efficacious the couple may have proved, there appears to us to be at least two serious theoretical faults in its construction. The first is the contact of atmospheric oxygen with the positive metal, whereby it is oxidised without giving rise to any electrolytic action through the fluid, beyond the comparatively small effect which may be occasioned by the solution of the oxide in the acid. The second is the contact of the bichromate solution with the negative element, at the surface of which, as we have seen, the gas hydrogen is liberated. This gas, as well as the zinc, which is also in contact with the salt, possesses an electro attraction for oxygen, whereby the effect of polarisation, through which the oxygen atoms of the salts are disposed in the direction of the zinc, is diminished, with a consequent loss of tension. These objections are both removed, however, when we allow atmospheric oxygen to come in contact with the negative plate only, and the bichromate solution with the zlnc plate only. The bichromate of potash is doubtless a very efficient agent for preventing the polarisation of the negative element by condensed hydrogen, but, when employed for this purpose, it should, in no case, be allowed to come into contact with the zinc element; and, on the other hand, when it is used to promote the oxidation of the zinc, it should be kept from contact with the negative element.

It is possible that means may yet be devised for destroying, by means of atmospheric oxygen, the effect of polarisation of the negative element, without having recourse to the mechanical means employed by M. GRENET to propel a current of air through the exciting fluid. A small portion of the oxide of manganese added to the dilute sulphuric acid in a cell with zinc-copper or zinc platinum elements, obviates the effect of polarisation, when the circuit is one of considerable resistance, by gradually supplying oxygen to the fluid; but, ultimately, the voltaic action is diminished through the electrolysis of the manganese salt which is formed. We have even found a marked effect to be produced by introducing a small quantity of straw or hay beneath the sur-

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face of the fluid; thereby maintaining it in an aerated condition.

The employment, as exciting fluids, of the alkaline manganates and permanganates, sold under the name of "Condy's disinfecting fluid," might possibly, under certain conditions, be found advantageous. We believe, however, that Mr. C. F. VARLEY has employed these powerful oxidizing agents in the battery without satisfactory results; and the experiments in which we have replaced nitric acid, by permanganate solutions, have hitherto proved equally unsuccessful. The addition of a substance to these solutions, which might increase their conductivity, without effecting their decomposition, would probably, however, render them available as a substitute for the corrosive fluid used in the batteries of GROVE and BUNSEN.

TELEGRAPHY IN NEW SOUTH WALES.

THE telegraph continues to make gradual progress in New South Wales. The line from Campbeltown to Wollongong, which places the latter town in communication with Sydney, was opened for messages on August 11. On the extension of Kiama the posts are all up, and the stretching of the wire was completed in August. A line is also being carried from Wollongong to Bellambi, a length of six miles, the posts for the Wollongong line being used for the greater portion of the distance. This line has been constructed by the Government upon a guarantee from persons interested in the port of Bellambi, of a return of 5 per cent. per annum upon its cost for its use. The extension from Mudgee to Wellington, a length of 46 miles, is finished, and will shortly be brought into use. On the extension from Orange to Wagga Wagga, which will pass through the Lachlan and Burrangong gold-fields, the posts are fixed for a length of 44 miles, but no wire has yet been stretched. On the line from Grafton to Tenterfield, the posts are up and the wire attached, for a length of 50 miles: and the line is pegged out as far as Tabulam. No further telegraphic extensions of importance are at present proposad to be carried out; but sums are placed on the estimates for 1863 for three branch lines, the construction of which is to be conditional on the completion of arrangements with applicants; the arrangements being that the inhabitants of the places to which the lines are preposed to be carried, guarantee to the Government a return of 5 per cent. on the cost and the working expenses. The extensions to be constructed upon this condition are—From Deniliquin to Hay, a length of 80 miles; from Wellington to Dubbo, 35 miles; and from Braidwood to Queanbeyn, 35 miles. The sum of £3,5u0 has been placed on the estimates for an additional wire from Sydney to Newcastle.

REPORT OF THE DEEP SEA SOUNDINGS TO THE WESTWARD OF IRELAND.

Made in H.M.S. "Porcupine," in June, July, and August, 1862.

[Continued from p. 10.]

Carrying out the system of sounding laid down for me in your orders, in the parallel of 51° 35′, we passed from 1,440 to 930 fathoms in a distance of 2·7 miles, or a little under 19 feet of dip to 100 feet horizontal, and this is the steepest incline we have met with.

The unsettled weather we experienced frequently interrupted our work, and on the 8th of July, having expended our coals, I ran into Galway to replenish, and obtain a fresh rate for our chronometers.

We were detained here by continual gales until the 21st, when the weather moderating, we again sailed, carrying out a line of soundings with us; but had scarcely arrived on our ground, when the weather became more severe than ever, and on the morning of the 24th, while lying to in a heavy gale, we had the misfortune to twist our rudder-head off. This compelled us to return to Galway for repairs, and in the absence of the proper means for effecting them, we were delayed there until the 6th of August. During this time, and, indeed, throughout the whole of our cruize, the weather was very unsettled, occasioning a great loss of time.

On the 8th of August we were enabled to sail from Cashell Bay, where, on leaving Galway, I had gone for shelter. Carrying out a line of soundings on the parallel of Slyne Head, at the distance of one hundred and twenty mile to the westward of it, we crossed the tail of a bank of 82 fathoms, coarse gravel. This being entirely new, I have named it the Porcupine Bank. It will be of use to vessels bound to Galway from the westward as a means of acertaining their position by the lead. The bottom both to the nortward and southward is deeper, being composed of fine dark sand, while the bank is composed of gravel and coarse sand.

August 10th, in lat, 35° 30′, long. 15°, found the current from a boat moored to the bottom S.E. ½ S. 0·5 knot, which agrees with that shown by our reckoning for the last two days. Numerous pipe fish, some with ova attached, were swimming on the surface; some of these were preserved.

Aug. 11th.—Our soundings this day taught us that in the parallel of 54° 10′, the Irish Bank does not extend so far to the westward, and that Rockal is probably a separate bank.

Aug. 12th.—Weather again unsettled, with a heavy sea. Having determined the N.W. limit of the Irish Bank, bore away towards the tail of the Rockal Bank, sounding at intervals in from 1,500 to 1,200 fathoms, shoaling as we approached the Rockal Bank.

Aug. 14th.—At noon observed Rockal with several fishing vessels near it. There being too much sea to do anything in the vicinity of the rocks, hove to for the night.

Aug. 15th.—Got observations for latitude and longitude; found the current setting with flood tide N. by E. 0·8 knot. The weather having become fine, with only a moderate swell, sent a boat with a party to land on the rock; but the sea broke so heavily round it that the officer in command thought it would be imprudent for them to do so. One of the party, Mr. Johns, the boatswain, succeeded in getting a footing, but not at the part where the summit is accessible.

The fishery is in the vicinity of the rock; but this very remarkable peak of a submarine mountain standing, as it does, in solitary grandeur above the ocean surface, is not unworthy of some attention in this report.

Rockal is in lat. 57° 35′ 53″ N., by meridian altitude of sun; long. 13° 42′ 21″ W., mean of A.M. and P.M. sights, four chronometers, sea horizon. The rock has an elevation of 70 feet above the sea, is about 250 feet in circumference at its base, and is composed of a coarse granite.*

The summit of the rock, sharp pointed and whitened by birds, can only be gained from its N.E. side, and landing is at all times difficult, for it is steep on all sides. On the N.E. side, however, is a small detached rock, called Haslewood Rock, uncovered at half-tide, with 30 fathoms of water between it and Rockal, from which it bears N.E. by N., a cable and a half distant.

Helen Reef, bearing S. 79° E. two miles from Rockal, has about 6 feet water over it at low water. It is so called from a vessel of that name that was wrecked on it, and is very dangerous. The situation of it is generally shown by its breakers, but towards high water, and in very fine weather, it only breaks at long intervals. From being small and steep too, there is then nothing to indicate the approach to it. To avoid it, keep Rockal clear of a W. by N. bearing. There is a safe passage between it and the rock.

The lowest estimate that was formed of the range of the tide (judging from the appearance of the rock), was 6 feet; but this seems large for a tide wave in mid ocean. Purdy's "Atlantic Memoir" presumes to discredit the existence of any danger near Rockal, but is mistaken.

From Rockal we steered for the Irish coast, when nearly midway between it and the Irish Bank, we obtained one sounding of 1,660 fathoms, and found the current here from a boat moored to the bottom, S.E. by E. ½ E., one knot.

From the edge of the Irish Bank I carried a line of soundings into Enis Head, and then proceeded to Valentia for coals. On receiving which, having carried out my instructions and effected the object of our cruize, I returned to Cork for further orders, getting a few soundings by the way.

In the course of our operations we found the donkey steam engine and the light iron reels for running the line off very serviceable, indeed indispensably necessary to our success. The bulldog machine fully answered the purpose of bringing up a large quantity of the bottom, but we could not always get the weight to detach. On one occasion, too much line having been paid out, the bight got between the jaws of the nipper and prevented its closing; this lost us our specimen, but it affords another illustration of the line going straight down on the weight, and the consequent absence of any under current.

In carrying out this service I received every assistance from the officers on board, who all united their best endeavours to bring our cruise to a successful termination.

With reference to the principal object of our inquiry, that of finding a more gradual slope into the bed of the ocean, I consider that our soundings, shown in the accompanying chart, clearly prove that the

* Specimens have been sent to various museums in Ireland.

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general dip of the bank presents no difficulty whatever to laying a cable either from Valentia or Loop Head, or any other part of the West coast of Ireland between Bantry and Blacksod Bays, that may offer facilities for securely landing and working it.

Much pains were taken by sounding at short intervals to discover if anything like a precipice existed. Our steepest incline shows a difference of level of 3,060 feet in 2·7 miles, or about 19 feet in 100 feet. On the parallel of 51° 20′ we have a dip of 7,680 feet in a distance of fourteen miles. The intermediate soundings give no evidence of a precipice; but a mountain of this height on the land would present an imposing appearance, with, perhaps, some steep escarpments.

On the adjacent coast of Ireland we have precipices of 2,000 feet in height, within half a mile of the shore. However these may have been caused, whether by the continued action of the Atlantic waves at their base, or by the erosive power of glacial or atmospheric agencies operating on their slopes, it is certain that the submarine mountains are not exposed to this action, or to any denuding process whatever. But it is more probable that any inequalities in them, arising from original formation, have been filled up by the gentle depositions of the soft clay that we found everywhere covering their slopes.

On examining the soundings, the slope will be found to vary from 6 to 19 feet dip in 100 feet horizontal, a dip that cannot possibly strain or injure the cable. The knowledge of this fact will, I trust, remove one of the supposed difficulties in the way of laying it, and help to forward the successful realization of this great national undertaking.—I am, &c.,

R. Hoskyn, Master and Surveyor.

Rear-Admiral Washington, F.R.S., &c., Hydrographer.

Abstract of the Experiments made with the Pressure Guages and Deep Sea Thermometers from the Sounding Log.

June 25th.—In 1,000 fathoms water.
Board of Trade min. ther., No. 49, registered 44°.
Johnson's metallic ther., No. 8·37°.
Johnson's pressure guage, did not act, the stopper had not moved.
Hearder's pressure guage, all the mercury ran out of the legs into the tube, probably from its having capsized on the bottom.

June 27th.—In 2,350 fathoms.
Board of Trade min. ther., lost by line carried away.
Johnson's metallic ther., lost by line carrying away.

July 22nd.—In 200 fathoms.
Johnson's pressure guage, did not act.
Board of Trade min. ther., registered 54°.
Johnson's metallic ther., No. 9, 49°.
Board of Trade min. ther., 50·5°.
Johnson's metallic ther., No. 9, 48·5°.

August 10th.—In 540 fathoms.
Hearder's pressure gauge, the mercury was all disjointed, some in outer tube, no result.
In 820 fathoms.
Hearder's pressure gauge, lost by line parting.
In 1,500 fathoms.
Board of Trade ther., No. 18, registered 59°.
In 1,550 fathoms.
Johnson's metallic ther., No. 9, 31°.

August 11th.—In 1,540 fathoms.
Hearder's pressure gauge, No. 2, on coming up, the short leg registered 750 fathoms; the long leg was full; in a few minutes after coming up the short leg fell to 1,000 fathoms.

August 12th.—In 690 fathoms.
Hearder's pressure gauge. No. 2, on coming up, the short leg registered 1,200 fathoms; the long leg was full: shortly afterwards the short leg registered 1,425 fathoms.

August 16th.—In 1,660 fathoms.
Board of trade ther., No. 18, 51°.

August 29th.—In 400 fathoms.
Johnson's pressure gauges, Nos. 1 and 2 did not act.
Repeated the experiment,—they did not act.
Hearder's pressure gauge, short leg registered 950 fathoms; long leg, 300 fathoms.

Every injunction of the inventors for using these instruments was strictly complied with by Mr. Davis, who took great pains to secure their efficient working.

Johnson's metallic thermometer appears to give good results.

I think the reading of the Board of Trade thermometer is sometimes vitiated by the index not retaining its position.

Johnson's pressure gauge never seemed to be, in the slightest degree, affected by pressure. Is it not possible that the water may pass freely round the cork without moving it? If the plug is forced into the tube with the finger, instead of compressing, the water passes it.

Hearder's pressure guage is of no practical use in its present form. The liability to fall on its side, on the bottom, will always interfere with its results.

R. Hoskyn.

In all cases, in the following soundings, the bottom was found and the depth fairly measured—but where the line parted in coming up the sounding being lost, the character of the bottom could not be ascertained.

Date.	Latitude.	Longitude.	Depth.	Nature of Soundings.
	° ′	° ′	Fathoms.	
June 25	50 44·5	11 36·5	900	Drab coloured sandy mud.
,,	50 55	11 52	980	Stiff sandy clay.
,,	50 56	12 6	1000	Stiff sandy clay.
,,	50 57	12 20	1080	Sandy clay.
,,	50 58	12 40	1120	Line broke from strain, 1,050 fms.
,,	50 59	13 0	1180	Sandy clay.
,,	51 0	13 22	1175	Sandy clay.
26	50 59	13 30	930	Sandy clay.
,,	51 3	14 46	510	No indication.
,,	51 4	15 6	710	Sp. sand.
,,	51 4	15 19	1550*	Line parted—no bottom found.
27	50 56	15 21	1900	Line parted at 1000 fathoms.
,,	51 9	15 59	2350	On site of Brazil Rock—a good up & down soundg.—lost at 2,250 f.
,,	51 19	15 32	2050	Line parted at 1,900 fathoms.
,,	51 19	15 15	1750	Good up & d. sndg.—lost at 1000 f.
28	51 25	15 15	1550*	No indication.
,,	51 35	15 19	1440*	Clay.
July 2	51 52	15 22	1200*	Line parted at 1,000 fathoms.
,,	51 51	15 21	1250	Line parted at 1,150 fathoms.
,,	51 50·5	15 31	1450	Sandy clay—snding unsatisfactory.
3	51 57·7	5 17	1250*	Parted at 1,000 fathoms.
,,	52 8	15 30	1240*	Sandy clay.
6	52 21	15 31	1570*	Sandy clay.
,,	52 18	15 15	710	Sandy clay.
,,	52 19	15 2·5	570	Sand.
23	52 58	15 8	1050	Line parted.
,,	52 58	15 20	1470*	Sandy clay.
Aug. 10	53 22·5	14 45	820	Line parted at 700 fathoms.
,,	53 22	15 0	1500*	Sandy clay.
,,	53 40	15 4	1550	Sandy clay and stones embedded. Greenstone & basalt ang. ½ in. sq.
,,	53 40	14 47	1300	
11	53 39	14 46	1120*	Line got into nippers.
,,	53 53·5	14 14	900	Muddy sand—parted at 800 fms.
,,	53 59	14 25	1540	Sandy clay & stones—lost at 1,400 f.
,,	54 0·5	13 58	1120	Sdy cly. Bank recedes E. Rockal is probably on a separate bank.
12	55 8	13 25	1350*	Sandy clay.
,,	54 6	12 50	690	Sandy clay.
,,	54 16	13 6	1580	No specimen, line parted.
,,	54 39	13 44	1500	Line parted at 1,400 fathoms.
13	55 14	14 42	1300	Line parted at 1,280 fathoms.
,,	55 33	14 40	1220	Line parted at 1,050 fathoms.
,,	55 53	14 38	800	Sandy clay.
16	55 31	12 11	1660	Mud.
17	54 20	12 44	840	No specimen.
,,	54 20	12 23	1380	Drab coloured sandy mud.
,,	54 20	12 7	980	Sandy clay.
28	52 40	15 38	1750	Sandy clay.
,,	52 45	15 15	1120	Sand and shells.

The foregoing report sets at rest the imagined difficulty of the precipitous character of the approaches from the sea bed to the western coast of Ireland; Mr. Hoskyn having found several depths (to which we have affiixed an asterisk in his tabulated statement) where the slope has been found by him in some as little as one in six—that of an ordinary shingle beech. A few more soundings would have been acceptable to the southward, but sufficient are obtained on a direct line to show that a cable may be laid there so as to gain the deep bed of the Atlantic by an easy descent. This would be better shown on a large scale, but we have sketched out this section on our chart to conveying an idea of the slope in that latitude, and probably sufficient

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data will be found in the report for others hereafter. The whole operations of the voyage are highly creditable to Mr. Hoskyn, and his report, as far as it goes, quite satisfactory, in regard to a line for a cable.—*From The Nautical Magazine.*

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST (*continued.*

1775—SIMMONS, John.—

[An Essay on the cause of Lightning, and the manner by which the Thunder Clouds become possessed of their Electricity, deduced from known facts, and properties of Matter, to which are added, Plain Directions for constructing and erecting safe Conductors, by John Simmons.—Rochester: printed and sold by T. Fisher; also by S. Crowder, Paternoster Row, London, MDCCLXXV.] —Pamphlet, 81 pages.

1776—BECCARIA, Giambatista.—

[A Treatise upon Artificial Electricity, in which are given solutions of a number of interesting Electrical Phenomena, hitherto unexplained, to which is added an Essay on the mild and slow Electricity which prevails in the atmosphere during severe weather. Translated from the original Italian of Father Giambatista Beccaria, Professor of Natural Philosophy, at the University of Turin. —London: printed for J. Nourse, Bookseller to His Majesty, MDCCLXXVI.]—4to., 1 vol., 457 pages, plates.

1776—GOLDSMITH, Oliver.—

[A Survey of Experimental Philosophy considered in its present state of improvement. Illustrated with cnts, in two volumes, by Oliver Goldsmith, M.B.—London: printed for T. Carman and F. Newberry, jun.. at No. 65, St. Paul's Church Yard, MDCCLXXVI.]—In two vols, 830 pages, plates.
Chapter 3, vol. 1, Magnetism. Chapter 4, vol. 1, Electricity.

1777.—LOVETT, R.—

[The Electrica lPhilosopher, containing: *a new system* of an universal *Plenum of elementary fire;* wherein the nature of elementary Fire is explaned, its office pointed out, its extensive Influence and Utility in explaining many of the most abstruse Phenomena of nature shewn, and the *Grand Desideratum* in particular, which has been hitherto either entirely given up as inexplicable, or else sought after in vain by the most able Naturalists, is at length happily obtained, viz.: the *cause* of *gravity*, the *cause* of *cohesion*, &c., &c. The greater part of the publication is disposed in the form of a dialogue as the most familiar method of conveying instruction; and the whole is offered to the public, by way of supplement, to the Philosophical Essays lately published by the same Author. To which is subjoined: A Postcript containing strictures upon the uncandid Animadversions of the monthly Reviewers on those essays. By R. Lovett, Lay Clerk of the Cathedral Church of Worcester.—Worcester. Printed for and sold by the Author in Sidbury. Sold also by Mr. Bew, and Mr. Bladon, in Paternoster Row. London: MDCCLXXVII.]—8vo., 290 pages, plate.

1777.—KIRBY, Thomas,—

[An analysis of the Electrical Fire; setting forth, from the lecturer's own experiments, that it neither attracts nor repels; nor is attracted or repelled by points, or, any other way, is not material nor inherent in bodies, nor in the clouds, &c. Together with an account of an uncommon effect of lightning, and dissertation on thunder clouds; showing that thunder is not caused by such clouds being impregnated with minerals; but by frozen or cold ones coming into a warm Atmosphere. Dedicated to Dr. Franklin. By Thomas Kirby. Printed for the Author.—No date to imprint. The preface is dated Chatham, 1777.]—Pam.

1778—LICHTENBERG, Geo. Christ.—

[Geo. Christ. Lichtenberg de Nova Methodo Natxram ac motum fluidi electrici investigandi commentatio. Prior, experimenta generalivra continans Lecta in conseni publico Societatis regial Scientiarum, MDCCCLXXVIII]—4to., 180.

1778—WESTLEY.—

[The Desideratum, or Electricity made plain and useful, by a lover of mankind and common sense. Fourth edition. London, printed by R. Hawes, and sold at the Foundery in Moorfields, and at the Rev. Mr. Wesley's Preaching Houses, in town and country, 1778.]—Pam.

1779—MAHON, Charles, Viscount (Earl Stanhope).—

[Principles of Electricity, containing divers new Theories and Experiments, together with an analysis of the superior advantages of high and pointed conductors. This treatise comprehends an explanation of an electrical returning stroke, by which fatal effects may be produced, even at a vast distance from the place where the lightning falls. By Charles, Viscount Mahon, F.R.S. London; Printed for P. Elmsley, in the Strand. MDCCLXXIX.] 4to., 263 pages. Plates.

1780—LYON, John.—

[Experiments and observations, made with a view to point out the errors of the present received theory of electricity; and which tend in their progress, to establish a new system, on principles more conformable to the simple operations of nature. By the Rev. John Lyon, of Dover, Kent. London: Printed for the author, and J. Dodsley, in Pall-Mall, and sold by Joseph Hall, bookseller, at Margate, and Robert Brydone, bookseller, at Dover, MDCCLXXX.] 4to., 280 pages. Plates.

1780—

[Newe Philosophische Ubhandlungen der baierischen Ukademie der Wissenschaften, Erster Band gedruckt ben Johann Paul Botter Aurfurstl Hof Ukademie und Landschafts buchdruckern. Contains: De Paradoxo Phoenomeno Magnitico, Magnetem Fortius Ferrum Purum, Quam Alium Magnetem Attrahere Commentatio Auctore Joh. Hen. Vern Swinden-Zueulter Band, contains: Vern Swinden Profess. Philos. Fremequer. Dissertatio de Analogies Electricitates et Magnetisme.]

1781—LYON, John.—

[Further Proofs that glass is permeable, by the Electric Effluvia, and that the electric particles are possessed of a polar virtue, with remarks on the Monthly Reviewers', animadversions on a late work, intituled, "Experiments and Observations, made with a view to point out the errors in the present received theory of Electricity." By the Rev. John Lyon, of Dover, Kent. London: Printed for the author, and J. Dodsley, in Pall Mall, and sold by Joseph Hall, bookseller, at Margate, and Robert Brydone, bookseller, at Dover, MDCCLXXXI.] 4to., 80 pages. Plates.

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1781.—MAGGIOTTO, Francesco.—

[Lettera di Francesco Maggiotto, Pittore ed Accademico della publica Accademia de Pettura Scultura ed Architettura, di Venezia e della Clementina di Dologna, All Illustre Professore Nell Universeta di Padova, il Signor Abate Giuseppe Toaldo. Sopra. Una Nuova Costruzione de Macchina. Elettrica.]—Woodcuts, Pamphlet, 1781.

1782.—ANON.—

[New Thoughts on Medical Electricity, or an Attempt to discover the real uses of Electricity in Medicine, in two Letters to a Friend. Sevenokes. Printed by Thomas Clout, junior. Sold by S. A. Comberlege (successor to J. Hinton) Paternoster Row, London, 1782. Price One Shilling.]—Pamphlet.

1782.—HOOPER, W.—

[Rational Recreations, in which the Principles of Numbers and Natural Philosophy, are clearly and copiously Elucidated, by a series of easy, entertaining, interesting experiments. Among which are all those commonly performed with the cards. By W. Hooper, M.D. The Second Edition corrected. London. Printed for L. Davis, Holborn; J. Robson, New Bond Street; B. Law, Ave-Maria Lane, and C. Robinson, Paternoster Row. MDCCLXXII.]—8vo., 4 volumes.

The first volume is marked MDCCLXXIII., but the three others are marked MDCCLXXII., which is, therefore, more probably the correct date. Contains: Vol. III., Electricity, page 1 to 110; Magnetism, 113 to 295.

1782.—MARAT, M.—

[Recherches Physiques sur l'Electricité par M. Marat, Docteur en Médicine et Médicin des Gardes du Corps de Monseigneur le Comte d'Artois. A Paris. De l'Imprimerie de Clousier, rue de Sorbonne allenant celle des Mathurino.

Chez. { Nijen l'aîné, Rue du Jardinet,
Nijen le cadet, Quai de Centi.
Belin, Rue Saint-Jacques.

Et au Bureau du journal de Physique rue a Hôtel Serpente. MDCCLXXXII. Avic Approbation and Privelége du Roi.]—One volume 8vo., plates.

1783.—NAIRNE,—

[The Description and use of Nairne's Patent Electrical Machine; with the addition of some Philosophical Experiments and Medical Observations. London: Printed for Nairne and Blunt, No. 20, Cornhill, MDCCLXXXIII.]—8vo., 62 pages, plates. Principally on Medical Electricity.

1783.—MILNER, Thomas.—

[Experiments and Observations in Electricity. By Thomas Milner, M.D., London: Printed for T. Cadell. In the Strand, MDCCLXXXIII.]—8vo., 111 pages, plates.

EFFECTS OF MAGNETIZATION ON THE ELECTRIC CONDUCTIVITY OF NICKEL AND OF IRON.

BY PROFESSOR W. THOMSON, F.R.S.

I HAVE already communicated to the Royal Society a description of experiments by which I found that iron, when subjected to magnetic force, acquires an increase of resistance to the conduction of electricity along, and a diminution of resistance to the conduction of electricity across, the lines of magnetization. By experiments more recently made, I have ascertained that the electric conductivity of nickel is similarly influenced by magnetism, but to a greater degree, and with a curious difference from iron in the relative magnitudes of the transverse and longitudinal effects.

In these experiments the effect of transverse magnetization was first tested on a little rectangular piece of nickel 1·2 inch long, ·52 of an inch broad, and ·12 thick, being the "keeper" of the nickel horseshoe (§ 143) belonging to the Industrial Museum of Edinburgh, and put at my disposal for experimental purposes through the kindness of Dr. George Wilson. Exactly the method described in § 175 of my previous communication referred to above, was followed, and the result readily found on the first trial, was as stated.

The effect of longitudinal magnetization on nickel was first found with some difficulty, by an arrangement with the horse-shoe itself, and magnetizing helix, the former furnished with suitable electrodes for a powerful current through itself, and the system treated in all respects (including cooling by streams of cold water) as described, for a corresponding experiment on iron. The result, determined by but a very slight indication, was, as stated above, that longitudinal magnetization augmented the resistance.

The magnetization of the small piece of metal between the poles of the Ruhmkorff electro-magnet being obviously much more intense than that of the larger piece under the influence merely of the smaller helix, I recurred to the plan of experiment (§ 175) by which the effect of transverse magnetization on the little rectangular piece of nickel was first tested, and I had an equal and similar piece of iron, and another of brass, all prepared to be tested, as well as the nickel, with either longitudinal or transverse magnetic force.

To each of the little rectangles of metal to be tested, a thin slip of copper, to serve as a reference conductor, was soldered longitudinally, and to the other end of the metal tested, a piece of copper to serve as an electrode, for the principal current, was soldered. The ends of a testing conductor, 6 feet of No. 18 copper wire, were soldered respectively to the last mentioned end of the tested metal, and to a point in the reference-conductor found, so that the resistance between it and the junction of the reference-conductor with the tested conductor, should be about equal to the resistance in the latter.

A single element, consisting of four large double cells of Daniell's (§ 63), exposing in all 10 square feet of zinc surface to 17 square feet of copper, was used to send the testing current through the conducting system thus composed, by electrodes clamped to the ends of the principal conducting channel, just outside the points of attachment of the testing conductor.

The electro-magnet was excited by various battery arrangements, in different experiments, at best by 52 cells of Daniell's, each exposing 54 square inches of zinc surface to 90 square inches of copper, and arranged in a double battery* equivalent to one battery of 26 elements each of double surface. By accident, only a single battery of 26 elements was used in obtaining the numerical results stated below.

The nickel was first placed between the flat poles of the electro-magnet, with its length across the line of force, and one galvanometer electrode being kept soldered to the junction of the nickel and the copper reference-conductor, the other galvanometer electrode was applied to the testing conductor, till the point (equipotential with that point of junction) which could be touched without giving any deflection of the needle, was found. A multiplying branch, 3 feet of No. 18 wire, was then soldered with its ends $\frac{3}{8}$ths of an inch on each side of this point, and, as soon as the solderings were cool, the corresponding point on this multiplying branch was found. The magnetizing current was after that sent in either direction through the coils of the electro-magnet, and it was found that the moveable galvanometer electrode had to be shifted over about $4\frac{1}{2}$ inches on the multiplying branch towards the end of the testing conductor connected with the nickel, that is to say, in such a direction as to indicate a *diminished resistance* in the nickel. When the same operations were gone through with the nickel placed longitudinally between the poles of the electro-magnet, the zero-point on the multiplying branch was shifted about 6 inches in the direction which indicated an *increased resistance* in the nickel.

The piece of iron similarly tested, gave effect in the same direction in each case, and the results originally obtained for iron were thus verified.

No effect whatever could be discovered when the piece of brass was similarly tried. It is much to be desired that experiments with highly

* This arrangement was found to give about the same strength of current through the coils of the electro-magnet, as a single battery of 52 of the same cells in series, and was therefore preferred as involving only half the amount of chemical action in each cell, and consequently maintaining its effect more constantly during many successive hours of use.

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increased power, and with a better kind of galvanometer, should be made, to discover whatever very small influence is really produced by magnetic force on the comparatively non-magnetic metals.

The shifting of the neutral point on the multiplying branch required to balance the effect produced by the longitudinal magnetization in the iron, was only from 1½ to 2 inches. Three inches were required to balance the opposite effect of the transverse magnetization.

Hence, with the same magnetic force, the effect of longitudinal magnetization in increasing the resistance, is from three to four times as great in nickel as in iron; but the contrary effect of transverse magnetization is nearly the same in the two metals with the same magnetic force. It may be remarked, in connexion with this comparison, that nickel was found by Faraday to lose its magnetic inductive capacity much more rapidly with elevation of temperature, and that it must consequently, as I have shown, experience a greater cooling effect with demagnetization* than iron, at the temperature of the metals in the experiment. It will be very important to test the new property for each metal at those higher temperatures at which it is very rapidly losing its magnetic property, and to test it at atmospheric temperature for cobalt, which, as Faraday discovered, actually gains magnetic inductive capacity as its temperature is raised from ordinary atmospheric temperatures, and which, consequently, must experience a heating effect with demagnetization and a cooling effect with magnetization.—*Proceedings of the Royal Society, June*, 1857.

* See Nichol's Cyclopædia of Physical Science, article 'Thermo-magnetism.'

THE SOIREE OF THE LONDON CAMBRIAN SOCIETY.

A *soirée, musicale, artistique, et scientifique* was given by this Society on Monday last, at the London Coffee House, Ludgate Hill, at which was exhibited an interesting collection of objects connected with the applications of electricity. We are glad to observe that, at similar *réunions*, where a concert or a dinner is ostensibly the principal feature of the evening, it is becoming a very general custom to promote, by similar means, a knowledge of the progress which is taking place in science or in art. In the present instance there was ample evidence that the pleasure and gratification of the evening were greatly enhanced by the opportunity for intellectual observation and conversation which was thus afforded. It is not within our province to refer to the merits of the concert, in which the Misses Edith and Kate Wynne, and the celebrated harpist, Mr. Ellis Roberts, took part; but there are several points of interest to be noticed in a brief description of the objects exhibited in illustration of the appliances of electrical science.

The Submarine and the London District Telegraph Companies had kindly offered every facility for the transmission of messages to various stations, both in England and abroad; but, owing to the crowded state of the streets, on the occasion of the Lord Mayor's procession, it was unfortunately found impossible to lead wires into the building.

Professor Wheatstone contributed two of his electro-magnetic dial instruments adapted for private use; which, placed at opposite extremities of the apartment, and duly connected by wires, were constantly, during the evening, employed by amateur telegraphists to realize the novel condition of conversing at a distance. The performance of the instruments, even in the hands of such inexperienced operators, was very satisfactory.

Mr. Thomas Allan exhibited specimens of insulated cores, constructed upon his patented system, in which the metallic conductor of copper, cased with steel wires, possesses sufficient tensile strength to resist the strain in laying; also the delicate electro-magnetic relay employed with his receiving instruments, worked by reverse currents.

Mr. C. F. Varley exhibited a new and ingenious instrument by the aid of which, a person, unacquainted with the details of electrical manipulation, may solve the hitherto difficult problem of discovering the exact spot in which a fault may exist in a long line of telegraph. The mode of using the apparatus was kindly explained by Mr. S. A. Varley; but the explanation could only be rendered intelligible to our readers by means of an illustration and diagrams, which we are unable, at the present moment, to furnish. It consists mainly of a differential galvanometer, which, in the first instance, is connected to the faulty wire, the circuit being completed by means of a return wire—the existence of which, it is to be observed, is necessary for the application of the system. The deflection of the needle is then balanced by a current from the same battery, which traverses the second coil of the galvanometer, and a series of resistance coils, which may be readily adjusted to equal the resistance of the circuit in which the faulty wire is included. The resistance thus obtained, gives the denominator of a fraction, of which the numerator is found by simply moving a lever, by means of which one pole of the battery is connected to earth, and readjusting the resistance coils to bring the needle again to zero. The fraction obtained represents the length of wire between the station at which the operation is conducted and the fault in the line.

Mr. Owen Rowland and Captain Tribe contributed a very complete collection of specimens of telegraphic cables actually laid, specimens of various "kinks" and "faults," which have necessitated the recovery and repair of such cables. Mr. Rowland also exhibited a galvanometer, an inductometer, and a Peltier electrometer, employed by him in testing for Government.

Messrs. Silver and Co. sent specimens of their patent india-rubber covered wire, which formed the standard insulated wire adopted by the Government Telegraph Committee in testing; and an improved ebonite insulator, constructed with a stem of ebonite instead of iron, and much stronger than those we have hitherto seen.

Messrs. Hall and Wells also exhibited specimens of wire insulated with caoutchouc, and of their patent cable, protected externally with hemp in combination with longitudinal steel wires, also a specimen constructed by them for the Indian Government.

M. Pulvermacher exhibited specimens of his newly invented galvano-piline, formed by coiling wires of zinc and of an alloy of copper in close proximity upon a strip of "swan skin," a material which is found to be well adapted to retain a supply of the exciting fluid (dilute acetic acid) during a considerable space of time. Upon the apparently simple problem of constructing a voltaic combination capable of producing a continuous physiological action, and sufficiently light and pliable to be worn upon the person without inconvenience, M. Pulvermacher has expended the greater part of a lifetime; and his endeavours to perfect one of the most important applications of electrical science have, we are glad to observe, been attended with very complete success. The miniature "tension battery," formed by a strip of the galvano-piline, will be found far more convenient in the treatment of rheumatic and neuralgic affections, and also somewhat more efficacious, than the original "chain," formed by coiling the wires, without contact, upon small pieces of porous wood. Very considerable difficulties, especially in the construction of machinery for the manufacture of the voltaic ribbon, have been encountered and overcome in obtaining the present result. The efficiency of the arrangement was fully shown by the decomposition of water, even when two individuals formed part of the voltaic circuit. A Peltier electrometer was charged to 20° by the contact of the finger, when the operator, standing upon a sheet of insulating material, held one of the extremities of a strip of the material, the other end being connected to earth, or simply held by a person uninsulated. The experiment is suggestive of the employment of the voltaic chain, instead of a battery occupying a considerable space, in many experiments where electricity of a certain degree of tension is required.

A fine collection of microscopes, including several binocular instruments, was also contributed for the occasion, one of the mounted objects, shown by Mr. William Davis, being a specimen of the *foraminiferæ*, obtained by Dr. Wallich from the depths of the Atlantic.

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ON THE APPLICATION OF OHM'S FORMULÆ TO PRACTICE.*

BY CAPTAIN SCHAW, R.E.

IN determining the size, number, and mode of combining the elements of a particular form of a voltaic battery to effect any special object, the theory of Ohm is of very great assistance. By this theory the equation $Q = \frac{T}{L + w}$ expresses the constant relation between the elements of the source of electricity and the work done. Q = the quantity of electricity in circulation, which may be measured by the deflection of a galvanometer, the decomposition of water, or the heating of a wire, as found most convenient. T = the electromotive force or tension of one pair, or element of the particular voltaic combination; it may be measured directly, when a number of elements are combined in series, by the effects of electrical attraction or repulsion, as shown by an electrometer; but no instrument has yet been constructed sufficiently delicate to measure directly the static electrical tension of *one* element of a voltaic battery. The electromotive force depending solely on the metals and liquids employed in that combination, is a constant for each battery. The size and distance apart, and number of the plates and other special arrangements of the combination, do not affect this electromotive force, although they do materially affect the effective force in circulation.

The electromotive force of a Daniel battery, for instance, depends entirely upon the excess of the affinity of the zinc for the oxygen of the water, above the sum of all the other affinities in the combination, viz., of the copper for the oxygen and sulphuric acid, and of the hydrogen for the oxygen.†

L = the liquid resistance or resistance to the passage of the current of electricity from the zinc to the copper in each cell. This is made up of the resistance of the liquid, and of the porous cell, and of the plates themselves. The last may generally be neglected, it is so small, although it shows the necessity of perfect metallic connexions between the pairs of plates. The resistance of the porous cell varies directly as its thickness and the closeness of the texture, and inversely as its surface interposed between the metals. The resistance of the liquid varies directly as the distance apart of the plates, and its specific resistance, and inversely as the opposed surface of the plates or sectional area of the liquid prism between them.

w = the resistance of the conductor, which varies directly as its length and as its specific resistance, and inversely as its sectional area.

And here two terms, which are of frequent occurrence in speaking of voltaic electricity, require to be defined—*quantity* and *intensity*.‡ Upon the *quantity* of electricity in circulation depends the amount of work done, whether it be the decomposion of water, the deflection of the needle of a galvanometer, the heating of a metal, or any other effect of dynamic electricity; and upon the *intensity*, or *tension* under which the electricity is generated, depends the quantity which can be put in circulation in a given time through a conductor of a fixed resistance.

In the equation $Q = \frac{T}{L + w}$, if $w = o$, that is, if the plates be connected by a conductor whose resistance is insignificant, then $Q = \frac{T}{L}$ representing the quantity of electricity in circulation in a voltaic pair or element of a voltaic battery, when $w = o$.

If n such elements be arranged in series, connecting the positive metal of each with the negative of the next, and the first positive and the last negative metals be connected by a conductor of insignificant resistance, we have n electromotive forces, and also n resistances, and the value of Q will remain unchanged for $Q = \frac{nT}{nL} = \frac{T}{L}$; whence we learn that, in cases when the external resistance is very small, little or no advantage will be derived from multiplying elements in series; but if the external resistance be considerable, the case is very different, with n elements so connected we can introduce n times as much external resistance without diminishing the quantity of electricity in circulation, as will be seen from the equation

$$Q = \frac{T}{L + w} = \frac{nT}{nL + nw}.$$

The quantity of electricity in circulation may be increased by diminishing either term of the denominator of the fraction $\frac{T}{L + w}$.

L may be diminished by approaching the plates nearer to each other; but to this there is a practical limit, owing to various causes; it may also be diminished by increasing the surface of the plates, and with them the area of the conducting prism of intervening liquid, and this increased surface may be obtained either by enlarging the plates or by connecting the positive plates of several pairs together, and also their negative plates.

w may be diminished by decreasing the length or increasing the sectional area of the wire, or, which comes to the same thing, by combining a number of elements in series.

$$Q' = \frac{T}{\frac{L}{n} + w} \quad \ldots (1)$$

$$Q'' = \frac{T}{L + \frac{w}{n}} \quad \ldots (2) = \frac{nT}{nL + w} \quad \ldots (3).$$

(1) Representing the increase due to diminished liquid resistance.
(2) Representing the increase due to diminishing the wire resistance.
(3) Representing the same increase by the combination of elements in series.

The comparative values of Q′ and Q″ evidently depend on the comparative values of L and w. If the liquid resistance be in excess of the external wire resistance, it will be best to increase the size of the plates, but if the external resistance be in excess, and that it cannot be directly diminished, Q may be most economically increased by arranging the battery in series of elements.

In the practical service of the electric telegraph, the currents passing between distant stations meet with very considerable resistance due to the conducting wires and the coils of fine wire in the instruments, while the liquid resistance in each element of a Daniell's battery in Muirhead's pattern is only equal to about a mile of ordinary conducting wire; hence it is necessary to arrange the elements in series to obtain the required force in circulation.

For local circuits which have but a small wire resistance, but in which it it required to circulate a considerable quantity of electricity to work the electro-magnets, batteries are used of a few elements in which the liquid resistance is diminished by enlarging the plates.

OVERGROUND WIRES.

In long circuits it is advantageous to use iron wire of No. 8 gauge, or even larger, in order to reduce, as far as possible, the resistance offered to the passage of the current of electricity. To investigate the question of the size of conducting-wire suitable to a particular case, it must be borne in mind that the coils of a needle instrument offer a resistance equivalent to from 12 to 25 miles of No. 16 copper wire, and those of a Morse instrument of from 50 to 200 miles, so that with two needle instruments in circuit, from 25 to 50 miles of resistance are due to the instruments alone; and if the instruments are 10 miles apart, the substitution of No. 16 iron wire for No. 8 iron wire will increase the resistance by only 65 miles of standard resistance; but if the stations are 100 miles apart, the use of No. 16 wire in the place of No. 8 wire, would add 650 miles of standard resistance, and the number of elements required to work the line would be too large for practice.

Let us examine the question by means of the equation $Q = \frac{T}{L + w}$. We know from experiment that to work one of the needle instruments used at the Royal Engineer's Establishment with a strong and rapid beat, three elements of the modified Daniell's battery are necessary. The liquid resistance of one of the elements of this battery has been found to be equal to about a mile of standard wire, and the resistance of the coils of the instruments is equivalent to about 20 miles. The force required to be circulated may therefore be expressed by $Q = \frac{3T}{3L + w} = \frac{3T}{23}$. If, now, we insert various wire resistances in this equation, we must increase the number of elements to maintain the same value for Q. Let x be the number of elements required, and we have, with 10 miles No. 8 wire and two instruments in circuit,

$$Q = \frac{3T}{23} = \frac{xT}{xL + 10 + 40} = \frac{xT}{x + 50}$$

$\therefore 3x + 150 = 23x$

$20x = 150$ and $x = 7{\cdot}5$, the number of elements required.

With 10 miles No. 16 wire (= 75 No. 8) and two instruments in circuit—

$$Q = \frac{3T}{23} = \frac{xT}{xL + 75 + 40} = \frac{xT}{x + 115}$$

$3x + 345 = 23x$

and $x = 18$ nearly, the number of elements required.

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* "Aide-Memoire of Military Sciences." Edited by Capt. Chas. Binney, R.E. Published by Messrs. Lockwood.

† *Vide* the leading article of last week, entitled "Chemical Theory, &c." According to our views, the *electromotive force* depends simply upon the affinity of the zinc for oxygen. The *opposing affinities* affecting merely the internal resistance of the battery.

‡ The word "intensité" is used by French writers in the same sense as we use the term quantity.

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With 100 miles No. 8 wire and two instruments—

$$Q = \frac{3T}{23} = \frac{xT}{xL + 100 + 40},$$ whence $x = 21$, the number of elements required.

With 100 miles No. 16 wire (= 750 miles, No. 8) and two instruments—

$$Q = \frac{3T}{23} = \frac{xT}{xL + 750 + 40},$$ whence $x = 118$, the number of elements required.

These calculations must not be taken as more than approximations to the truth, so much depends upon the degree of perfection of insulation, that it is impossible to make exact calculations on the subject; practical experiments can only *decide* the battery power requisite for the working of a telegraph line. Nevertheless, the above considerations are correct in principle, and should govern both the selection of the telegraph wire for particular cases, and the number of batteries estimated for as probably necessary to work any projected line of telegraph. As a rough approximation, Mr. Latimer Clark states that in dry weather, with a well-insulated line of No. 8 iron wire suspended in the air, one element of Daniell's battery to every four miles of line may be taken as a fair average, and that this number must be doubled under the unfavourable circumstances of wet weather, imperfect insulation, and old batteries. In this calculation, each needle instrument may be taken as representing only five miles of line wire, owing to the more perfect insulation of the fine wire in the coils.

THE GALVANIC CIRCUIT INVESTIGATED MATHEMATICALLY

BY DR. G. S. OHM.

[Continued from p. 8.]

The previous considerations are also sufficient to indicate the process which is carried on when the galvanic circuit is divided at any place into two or more branches. For this purpose I call attention to the circumstance, that at the time we found the equation $S = \frac{A}{L}$, we also obtained the rule that the magnitude of the current in any homogeneous part of the galvanic circuit is given by the quotient of the difference between the electrical forces existing at the extremities of the portion and its reduced length. It is true, this rule was only advanced above for the case in which the circuit nowhere divides into several branches; but a very simple consideration, analogous to the one then made, derived from the equality of the abducted and adducted quantity of electricity in all sections of each prismatic part, is sufficient to prove that the same rule holds good for every single branch in case of a division of the circuit. Let us suppose that the circuit be divided, for instance, into three branches, whose reduced lengths are λ, λ', λ''; and, moreover, that at each of these places the undivided circuit and the single branches possess equal electrical force, and consequently no tension occurs there, and designate by a the difference between the electrical forces at these two places; then, according to the above rule, the magnitude of the current in each of the three branches is—

$$\frac{a}{\lambda}, \quad \frac{a}{\lambda'}, \quad \frac{a}{\lambda''};$$

whence it directly follows *that the currents in the three branches are inversely as their reduced lengths*; so that each separate one may be found when the sum of all three together is known. But the sum of all three is evidently equal to the magnitude of the current at any other place of the non-divided portion of the circuit, for otherwise the permanent state of the circuit, which is still constantly supposed, would not be maintained. If we connect with this the conclusion resulting from the above considerations, namely, that the magnitude of the current, and the nature of each homogeneous part of the circuit, give the dip of the corresponding straight line, representing the separation of the electricity, we are certain that the figure of the separation belonging to the non-divided portion of the circuit must remain the same so long as the current in it retains the same magnitude, and *vice versâ*; whence it follows that the variability of the current in the non-divided portion necessarily supposes that the difference between the electrical forces at the extremities of this portion is constant. If we now imagine, instead of the separate branches, a single conductor of the reduced length, A, brought into the circuit which does not at all alter the magnitude of its current and its tensions, then, according to what has just been stated, the difference between the electrical forces at its extremities must still always remain a, and consequently be—

$$\frac{a}{\Lambda} = \frac{a}{\lambda'} + \frac{a}{\lambda} + \frac{a}{\lambda''},$$

or

$$\frac{1}{\Lambda} = \frac{1}{\lambda} + \frac{1}{\lambda'} + \frac{1}{\lambda''},$$

which equation serves to determine the value of Λ. But if this value is known, and we call A the sum of all the tensions in the circuit, and L the reduced length of the non-divided portion of the circuit, we obtain, as is known, for the magnitude of the current in the last-mentioned circuit

$$\frac{A}{L+\Lambda},$$

which is equal to the sum of the currents occurring in the separate branches. Now since it has already been proved that the currents in the separate branches are in inverse proportion to one another as the reduced lengths of these branches, we obtain for the magnitude of the current in the branch whose reduced length is λ,

$$\frac{A}{L+\Lambda} \cdot \frac{\Lambda}{\lambda};$$

in the branch whose reduced length is λ',

$$\frac{A}{L+\Lambda} \cdot \frac{\Lambda}{\lambda'};$$

and in the branch whose reduced length is λ'',

$$\frac{A}{L+\Lambda} \cdot \frac{\Lambda}{\lambda''}.$$

This remote, and hitherto but slightly noticed peculiarity of the galvanic circuit, I have also found to be perfectly confirmed by experiment.*

I herewith conclude the consideration of such galvanic circuits which have already attained the permanent state, and which neither suffer modifications by the influence of the surrounding atmosphere, nor by a gradual change in their chemical composition. But from this point the simplicity of the subject decreases more and more, so that the previous elementary treatment soon entirely disappears. With respect to those circuits on which the atmosphere exercises some influence, and whose condition varies with time, without this change originating in a progressive chemical transformation of the circuit, and is thus distinguished from all the others by the magnitude of its current being different at different places, I have been content, with respect to each of these, always to treat of only the most simple case, as they but rarely occur in nature, and in general appear to be of less interest. I have adopted this plan the more willingly, as I intend to return to this subject at some future time. But with regard to that modification of galvanic circuits which is produced by a chemical change in the circuit, proceeding first from the current, and then again reacting on it, I have devoted separate attention to it in the Appendix. The course adopted is founded on a vast number of experiments performed on this subject, the communication of which, however, I omit, because they appear to be capable of being far more accurately determined than I was able to do at that time, from failing to attend to several elements in operation; nevertheless, I consider it proper to mention the circumstance in this place, in order that the careful manner with which I advance in the inquiry, and which I consider to be due to truth, may not operate more than is just against its reception.

I have sought for the source of the chemical changes caused by the current, in the above-described peculiar mode of separation of the electricity of the circuit; and, I can scarcely doubt, have at least found the main cause. It is immediately evident that each disc belonging to a section of a galvanic circuit, which obeys the electric attractions and repulsions, and does not oppose their movement, must in the closed circuit be propelled always towards one side only, as these attractions and repulsions, in consequence of the continually varying electric force, are different at the two sides; and it is mathematically demonstrable that the force with which it is driven to the one side, is in the ratio compounded of the magnitude of the electric current and of the electric force in the disc. It is true, however, that merely a change of position in space would be immediately produced by this. But if this disc be regarded as a compound body, the constituent parts of which, according to electro-chemical views, are distinguished by a difference in their electrical relation to one another, it thence directly follows that this one-sided pressure on the various constituent parts would in most cases act with unequal force, and sometimes even in contrary direction, and must thus excite a tendency in them to separate from one another. From this consideration results a distinct activity of the circuit, tending to produce a chemical change in its parts, which I have termed its *decomposing force*, and I have endeavoured to determine its magnitude for each particular case. This determination is independent of the mode in which the electricity may be conceived to be associated with the atoms.† Granting, which seems to be most natural, that the electricity is diffused proportionately to the mass over the space which these bodies then occupy, a complete analysis will show that the decomposing force of the circuit is in direct proportion to the energy of the current, and, moreover, that it depends on a co-efficient, to be derived from the nature of the constituent parts and their chemical equivalents. From the nature of this decomposing force of the circuit, which is of equal energy at all places of an homogeneous portion, it directly follows, that

* Schweigger's *Jahrbuch*, 1827.

† I shall shortly have occasion to speak of the peculiar import of this remark, when I shall attempt to reduce the actions of the parts of a galvanic circuit on one another, as discovered by Ampère, to the usual electrical attractions and repulsions.

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when it is capable of overcoming, under all circumstances, the reciprocal connection of the constituent parts, the separation and abduction of the constituents to both sides of the circuit are limited solely by mechanical obstacles; but if the connection of the constituent parts *inter se*, either immediately at the commencement everywhere, or in the course of the action anywhere, overcome the decomposing force of the circuit, then from that time no further movement of the elements can take place. This general description of the decomposing force is in accordance with the experiments of Davy and others.

There is a peculiar state which seems to be produced in most cases of the separation of the two elements of a chemically compound liquid, which is especially worthy of attention, and which is caused in the following manner. When the decomposition is confined solely to a limited portion of the circuit, and the constituent parts of the one kind are propelled towards the one side of this part, and the constituent parts of the other kind to its oppsite sidee, then, for this very reason, a natural limit is prescribed to the action; for the constituent part preponderating on the one side of any disc, within the portion in the act of decomposition, will, by force of its innate repulsive power, constantly oppose the movement of a similar constituent to the same side, so that the decomposing force of the circuit has not merely to overcome the constant connection of the two constituents *inter se*, but also this reaction of each constituent on itself. It is hence evident that a cessation in the chemical change must occur, if at any time there arises an equilibrium between the two forces. This state, founded on a peculiar chemical and permanent separation of the constituents of the portion of the circuit in the act of decomposition, is the very one from which I started, and whose nature I have endeavoured to determine as accurately as possible in the Appendix. Even the mere description of the mode of origin of this highly remarkable phenomenon shows that at the extremities of the divided portion no natural equilibrium can occur, on which account the two constituents must be retained at these two places by a mechanical force, unless they pass over to the next parts of the circuit, or, where the other circumstances allow, separate entirely from the circuit. Who would not recognise in this plain statement all the chief circumstances hitherto observed of the external phenomenon in chemical decompositions by the circuit.

If the current, and, at the same time, the decomposing force, be suddenly interrupted, the separated constituents gradually return to their natural equilibrium; but tend to re-assume immediately the relinquished state, if the current is re-established. During this process, both the conductibility, and the mode of excitation between the elements of the portion in the act of decomposition, obviously vary with their chemical nature; but this necessarily produces a constant change in the electrical separation, and in the magnitudes of the current in the galvanic circuit dependent thereon, which only finds its natural limits in the permanent state of the electrical separation. For the accurate determination of this last stage of the electric current, it is requisite to be acquainted with the law which governs the conductibility and force of excitation of the variable mixtures, formed of two different liquids. Experiment has hitherto afforded insufficient data for this purpose, I have, therefore, given the preference to a theoretical supposition, which will supply its place until the true law is discovered. With the help of this law, which is not altogether imaginary, I now arrive at the equations which make known for each case all the individual circumstances constituting the permanent state of the chemical separation in the galvanic circuit; I have, however, neglected the further use of them, as the present state of our experimental knowledge in this respect did not appear to me to repay the requisite trouble. Nevertheless, in order to compare in their general features the results of this examination with what has hitherto been supplied by experiments, I have fully carried out one particular case, and have found that the formula represents very satisfactorily the kind of wave of the force, as I have above described it.*

Having thus given a slight outline of the contents of this memoir, I will now proceed to the fundamental investigation of the individual points.

PULVERMACHER'S GALVANO-PILINE.

AMONGST the medical galvanic apparatus we have examined at the Exhibition, we find that newly invented by Mr. Pulvermacher particularly worthy of notice, since, by this invention, he has realized a new medico-galvanic system, long desired by the most eminent medical practitioners, as it combines great therapeutic value with simplicity of application.

In contradistinction to the system in which the administration of shocks, by *intermittent currents*, derived from complicated cumbrous machines, is the sole method of application, Mr. Pulvermacher applies a *continuous current, free from shocks, for a lengthened period of time*, in a manner entirely in harmony with the nerves' electrical functions in the human body; but as continuous currents can only be obtained by the voltaic battery—which, in its ordinary form, is of large bulk, heavy, difficult to manage, and to graduate the strength, more adapted to the philosophical cabinet than the chamber of the patient—it presents obstacles which act as a prohibition to its use, especially when the influence of the current is to be maintained for any length of time. These obstacles are now completely overcome by the invention of Mr. Pulvermacher's galvano-piline bands, which may be thus described. The galvano-piline is a fabric composed of zinc and copper wire, wound by mechanical means in flat helices upon a porous tissue, flannel or swans' skin. In order to prevent the metallic contact of the zinc and copper, the latter is covered with threads of cotton in distant helices; thus a metallic band of great flexibility is formed. The galvano-piline is made according to the purpose to which it is to be applied, in any length or width, and produces, when wetted with vinegar, an amount of electricity, in quantities in proportion to the amount of zinc surface. This large quantity having no penetrating powers upon the human body, it is transferred into the intensity required by subdividing the wires into elements, by cutting and soldering their ends in such a manner that one zinc end forms an element, which is brought into good permanent voltaic contact with the copper end of the element next in order. At these places where voltaic contact is established, the capillary connection between the elements is intercepted by the melting in of a resinous substance, which thus prevents the recomposition of the electricity set free through the action of the existing fluid on the zinc. According to the purpose required, the galvano-piline is cut into pieces of the length and breath necessary, which are provided at their ends (poles) with appliances for fastening, and transmitting the electricity to any part of the body.

Galvanic contrivances wearable upon the body, have frequently been brought to light by others, but as the voltaic arrangement between the zinc and copper, was not complete, they have been useless in their electrical effects. Mr. Pulvermacher has been the first to realize a genuine voltaic battery, wearable upon the body. It is evident that a fabric, possessing the qualities enumerated above, is applicable with the same ease and comfort, as a poultice or compress, as simply wetting with a little vinegar, more or less diluted, according to the energy of the current desired, is all that is necessary.

Whatever may be the variety of diseases treated beneficially by this invention, as stated by extracts, compiled in a pamphlet entitled, "Pulvermacher's Medico-Galvanic System," we limit ourselves to reporting what we have seen of the working of the apparatus, namely the decomposition of water, the action on the galvanometer, and electroscope, the production of muscular contraction, of sparks before the eyes, &c., &c. Yet we are bound to believe the evidence of such well known authors and physicians, as Mr. Charles Locock, Dr. Pereira, Dr. Golding Bird, Drs. Radcliffe, Russell, Reynolds, James, and Thompson, Mr. Harry Scoff, &c., &c., as well as the testimony of numerous patients, the names and addresses of whom are given.

A NEW FORM OF TENSION BATTERY.

A BATTERY constructed as follows will, from its simplicity and compactness, be found very convenient for experimental purposes where considerable tension is required. Procure a number of **U** or **V** shaped tubes of glass of equal size, to be obtained at the glass-blowers, from $\frac{1}{8}$ to $\frac{3}{4}$-inch in diameter, according to the *quantity* required in the current. Mix some plaster-of-paris with cold water in a jug, and pour into each tube sufficient to fill up the bend, so as to form a diaphragm separating the two arms of the tube. When the plaster has set, arrange the tubes, twelve or twenty together, in a trough of wood or gutta-percha, of just sufficient breadth to hold the tubes transversely. One arm of each tube, say on the right hand side of the trough, may now be filled with dilute sulphuric acid, and the portions of the tubes on the left hand side of the trough with a saturated solution of sulphate of copper. In this case, the voltaic elements may be strips of copper and zinc, the former immersed in the copper solution, the latter, which should be amalgamated, in the dilute acid. The amalgamation is easily performed by placing half an ounce of mercury in a soup plate, covering it with water acidulated with sulphuric acid, and rubbing the acid and mercury together over the surface of the zinc with a piece of flannel, or a cork. The zincs will thus be on one side of the trough, and the copper elements on the other side. The zinc of the first **U** tube is to be united with the copper of the second tube, the zinc of the second tube with the copper of the third.—and so on to the end of the series; the copper element of the first tube, and the zinc of the last, having wires attached to them which constitute the poles of the battery. To save the trouble of uniting the elements with wire, strips of copper and zinc, of sufficient length, when united, to extend

* Schweigger's *Jahrbuch*, 1826. Part 2.

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across the trough and to plunge into dissimilar fluids of the two tubes in juxtaposition, may be soldered together, end to end, and neatly bent to the required form. A battery of this description, occupying but very little space, is as efficient for most experimental purposes as an equal number of large size cells of Daniell.

Where great constancy is not required, the diaphragm of plaster may be dispensed with, and very good results obtained with a single exciting fluid of dilute sulphuric acid, to which may advantageously be added a small proportion of nitric acid, or of a solution of nitrate of potash (saltpetre).

Owing to the considerable internal resistance of this form of battery, it is not adapted for experiments, such as the production of the electric light, where considerable quantity as well as tension is required. We have, however, obtained the arc of flame between charcoal points with a series of forty tubes upon the principle of Grove's, or of Bunsen's, battery; the diaphragm, in this instance, being a plug of gun-cotton, the exciting fluids dilute sulphuric and concentrated nitric acids, and the elements amalgamated zinc and platinum or charcoal.

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Fine Para	2s. 1d. per lb.
Negro	1s. 3d. to 1s. 4d.
Java	1s. 6d. to 1s. 7d.

GUTTA PERCHA

Fine	2s. 4d. to 0s. 0d. per lb.
Genuine Mixed	1s. 8d. to 2s. 0d. „
Ordinary Reboiled	1s. 0d. „

November 12, 1862.

WM. KIRKMANN,
4, Howford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	———
20	Do. B 7 per cent. till 1862 .	—	———	———
Stock	Electric Telegraph . .	100	100 to 103	———
25	Do. New	20	———	———
5	London District Telegraph .	4¼	4 to 3 dis.	———
4	Lond. & S. Ireld. Direct Tel.	all	———	———
10	Mediterranean Extension Tel.	all	3 to 4	3¼
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ½	———
1	Do. registered . . .	all	⅜ to ½	———
10	Do. „ . . .	all	4 to 6	———
2	Telegraph to India . .	1	¾ to ½ dis.	———
5	United Kingdom Telegraph .	8	½ dis. to par.	2¾

DR. PHIPSON ON PHOSPHORESCENCE.

(*From the Chemical News.*)

PHOSPHORESCENCE is certainly one of the most interesting subjects that present themselves to the physicist or the chemist. It is not surprising, therefore, that Dr. Phipson should have laboured long and widely in this field, for it is almost certain that researches upon a subject so little known, and which has hitherto been studied only in some of its details, must meet with their reward, and open new paths in science. The author has already published several short papers upon phosphoric phenomena; but in the present curious and interesting volume he has brought forward not only the results of his own researches, but everything he has been able to glean from other sources concerning phenomena of phosphorescence.

The reason why many phosphoric phenomena, though they cannot be looked upon as of rare occurrence, have hitherto escaped the observation of most people, is obvious from the fact, that we are in the habit of closing our eyes as night approaches. And the wonder is how, under such circumstances, so many chemical substances which emit light have been discovered. A person who has once shaken up, in the dark, a glass bottle containing about a pound of nitrate of uranium, for instance, and witnessed the magnificent phosphorescence thus produced, is not likely ever to forget it. Indeed, there is something exceedingly beautiful in this spontaneous emission of light by various matters; and whether we witness the phosphorescence of a mineral, or a fungus, a firefly, or a polype,—whether we find ourselves accidentally in a self-luminous mist, or witness the phosphorescence of the snow beneath our feet, our attention becomes riveted in an unusual manner to these light-emitting objects.

In the volume before us the author has had to contend with a serious difficulty. He has endeavoured to render it interesting, not only to those whose lives are devoted to physical and chemical research, but also to that class of society which the French designate *gens du monde*. Hence, an almost romantic introduction treating of the discovery of solar phosphorus by the cobbler of Bologna, and that of the element phosphorus by the alchemist Brandt, which forms, however, an excellent prelude to the work. Hence, also, a number of very good wood-cuts of minerals, plants, and animals endowed with extraordinary phosphoric properties, which are dispersed throughout the text.

The scientific portion of the work is divided into four parts, the first of which treats of the phosphorescence of mineral substances, the second of vegetable phosphorescence, and the third of phosphorescence in animals; the fourth division is devoted to history, theory, and practical considerations. In the first part we have, also, a long chapter upon some very curious cases of meteorological phosphorescence, together with considerations upon the phosphoric light of the moon, of Venus, and other planets; and at the end of the volume we have an Appendix (by no means the least interesting portion), containing a list of the principal works which have contributed to our present knowledge of phosphorescence, from the treatise of Fabrico of Aquapendente, in the sixteenth century, down to the most recent researches of the present day, most of which are analysed in a few phrases. We regret that the author has omitted in this list the name of Dr. Pring, whose excellent researches on the light of the *Noctiluca* preceded those of Quatrefages and Verhaeghe, quoted in the text.

Although people who really enjoy the beauties of nature are apt to pay little attention to practical details, yet Dr. Phipson has thought proper to show that phosphorescence is far from being devoid of utility. He has proved, for instance, that the oxy-hydrogen or lime light, which is, without exception, the most brilliant light man has ever produced, is a phosphoric luminosity. "If a piece of borax," says our author, "be heated before the blowpipe, it melts when it has attained a red heat. If it be now allowed to cool, and a little lime sprinkled over it, on applying heat a second time, the lime becomes vividly phosphorescent long before the borax is at all affected by the heat. It is, therefore, evident that the lime glows vividly with phosphoric light, long before its temperature has attained what is termed a red heat."

As concerns the phosphorescence of mineral and chemical substances, we find this phenomenon induced by insolution, or exposure to the sun, by heat, friction, cleavage, crystallization, percussion, molecular or chemical change, and by electricity. It is the so-called actinic or chemical rays which excite the phosphorescence by insolation; the red rays of the other extremity of the spectrum often extinguishing the light produced by the violet end. These are precisely the rays which cause chlorine and hydrogen to combine, and which accomplish the wonderful change upon the photographer's paper. Referring again to this remarkable case of phosphorescence in the theoretical portion of his work, Dr. Phipson says:—

"My own idea of phosphorescence after insolation is as follows:—The light of the sun, acting upon a mineral substance, occasions a certain vibration (electric, chemical, or magnetic); but this vibration not being able to continue when the action of light ceases, that is, when the substance is placed in obscurity, the body gives back light whilst losing the vibration (electric, chemical, or magnetic) occasioned in it by the rays of the sun. *The body in question does not, in this case, give back the entire quantity of light it has received, but a quantity equivalent to the electric, chemical, or magnetic vibration induced in it by the direct influence of the solar light.*" The author goes on to show that a magnetic vibration is probably commonest, alluding to some curious experiments made by Grove in 1845.

It is evident that a similar conception would apply to phosphorescence by heat, chemical action, electricity, &c. Many cases of phosphorescence are closely allied to electricity, for we find that bodies, which are *bad conductors*, are very apt to become phosphorescent, whilst those which are good conductors rarely or ever manifest the phenomenon.

The following is a list of the more important phosphorescent substances treated of in the first part of the work before us. Fluorspar, apatite, blende, feldspar, wollastonite, calamine, chalkosine, oxide of zinc, lepidolite, samarskite, gadolinite, mica, quartz, amber, boraic acid,

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chlorate of potash, phosphate of lead, phosphorus, sulphur, sodium, potassium, arsenic, tellurium, stibine, hypophophites of soda and lime, sulphate of potash and soda, arsenious acid, nitrate of uranium, calomel, titanic and tantalic acids, sugar, mannite, lactine, valerate of quinine, sulphate of quinine, cinchonine, oxides of zirconium, chromium, iron, &c., sulphides of barium, strontium, calcium, diamond, lime, potash, soda, magnesia, oxide of molybdenum, vanadic acid, antimoniate of copper, phosphate of magnesia, phosphoretted hydrogen, oxygen, sulphurous acid, alcoholic vapours, vapours of turpentine, vapours of bichloride of tin, platinum, paper, teeth, ice and snow, water (whilst freezing), water (as vapour), &c., &c.

All these substances have been seen to become luminous in the divers circumstances alluded to above.

With regard to that mysterious phenomenon known as the *Will-o'-the-Wisp*, Dr. Phipson, after discussing the various theories brought forward to explain it, shows that several distinct phenomena appear to have been classed under this name; but as regards our English *Will-o'-the-Wisp*, which flickers over boggy lands, it is evidently nothing more than ignited marsh-gas (carburetted hydrogen), the same gas which spontaneously inflames in coal mines, the specific gravity of which is about one-half that of air. Its faint flame is always invisible in the day-time, but becomes visible as night approaches, burning very widely from the lightness of the gas. Some years ago, Mr. Blesson succeeded in lighting a piece of paper by the flame of a *Will-o'-the-Wisp*.

We cannot follow the author in his investigation of the various meteorological productions of light, in those curious cases of emission of light by nasturtiums, lilies, poppies, &c., and among the host of animal organisms endowed with phosphoric properties. The author has given the name of *subjective phosphorescence* to the light which is emitted when the optic nerve is injured by a wound, be electricity, by the use of narcotic medicines, &c. "A production of light in the above circumstances," says Dr. Phipson, "is exceedingly interesting, and tends, perhaps, more than we are aware, to establish the fact, that the phenomena of light are owing to a *vibratory movement of matter*."

Indeed, the volume which we have so imperfectly noticed cannot fail to have a marked influence upon the study of light, and as such, we heartily recommend it to all inquiring minds. We will only add that it has been brought out with the usual care and elegance which characterises most of Mr. Lovel Reeve's scientific publications.

Practical Chemistry.

EXPERIMENTS WITH THE ALKALINE PERMANGANATES.

Condy's Disinfecting Fluid.

TO TEST WATER FOR ORGANIC IMPURITIES.

Take any number of tumblers; fill up one with distilled water, another with ordinary drinking water from a pump, rain water butt, or other supply, and the rest with various samples of water more or less contaminated with organic impurities, such as sewage water. Add to each of them, drop by drop, Condy's Fluid (crimson) till the contents begin to assume a decidedly pink hue. This effect will be produced, in the case of the distilled water, if pure, by a single drop; more will be required by the drinking water, which, after standing a little while, will show some signs of muddiness, and a still larger portion by the other samples, in which a brown precipitate will soon form. The quantity of fluid required and the amount of muddiness produced in each, will be the measure of the relative impurity of the several waters. This experiment may be repeated with other deodorizing fluids, and the results contrasted with those produced by Condy's. By having a separate set of glasses for each of the deodorizers to be tried against one another, the comparison will of course be more conclusive.

TO PROVE THE PERMANENT NATURE OF THE ACTION OF CONDY'S FLUID.

To the above, or other similar samples of water, after treatment with the various deodorizing agents, add a few drops of sulphuric acid; in those in which chloride of zinc or other such deodorizer has been used, any offensive odour which they previously had will be immediately revived, whereas no such effect will follow on adding the acid to those waters that have been treated with Condy's Fluid.

TO PURIFY WATER ON A PRACTICAL SCALE.

Pour into a hogshead of offensive drinking water one wine glassful of Condy's Fluid, and mix with a stick or lath. Generally this quantity will render it as sweet as fresh water; should it require more, add half a wine glassful. So long as organic matter remains, which is known by the pink colour of the fluid gradually vanishing—add the fluid. If a trace too much has been used, continue stirring, or immerse a stick or lath, and the colour will disappear. Let it stand, and any suspended matter present will subside or filter.

The purifying action of Condy's Fluid on water will appear very evident on carefully comparing a sample of common drinking water, after its treatment by the fluid, with another of the same water taken previously to being treated. Filter both through clean blotting paper, and let a person taste them alternately blindfold, or without being aware which of them was the one which had been operated upon. A peculiar purity of taste and smell which characterises the purified water, and can be compared to nothing so well as to the fresh dew of the country, will cause the two samples to be very soon distinguished from each other. In most instances, a marked difference of colour will also be perceptible on placing a glass of each on a sheet of white paper, and looking through them upon it: the purified water will generally appear more colourless and brilliant than the other.

TO REMOVE TAINT FROM MEAT.

Take a small piece of fish, beef, or other flesh, place it on a plate, and covering it over with an inverted tumbler, there leave it. When it has acquired a decided taint, remove it, and after making several incisions, immerse it in a solution of one table-spoonful of Condy's Fluid in a quart of water. Allow it to remain for about ten minutes, after which it may be removed and washed with pure water, when it will be found to be free from taint.

TO DEMONSTRATE THAT THE EXHALATIONS FROM THE LUNGS ARE LOADED WITH OXIDIZABLE ORGANIC MATTERS.

Fit a wide-mouthed white glass bottle, with a bung, through which pass two tubes, after the manner of a common sulphuretted hydrogen apparatus, one short and the other long enough to reach inside to the bottom of the vessel. Fill it three-fourths full of pure water, slightly coloured with Condy's Fluid (crimson.) To the outside end of the longer glass tube fit a flexible caoutchouc tube, capable of being attached by its free extremity, to the nozzle of a pair of bellows. On blowing air through the water by means of the bellows, if no dust be present, but little or no effect will be produced on the colour of the contents of the bottle; but when the bellows is removed, and the mouth applied, so as to introduce the breath from the lungs, discolouration will soon show itself, after setting the bottle aside for a time.

TO DETECT AND PURIFY IMPURE AIR IN ROOMS, &C.

Add a tea-spoonful of Condy's Fluid (crimson) to a large jug or ewer of water, and empty the contents, in equal portions, into two hand-basins. Place one of these basins in a water-closet or ill-aired place, and the other in a well-aired hall, or in the open air. After allowing them to remain during several hours, bring them together, and compare the appearances in each. In the former, the water will be found to have lost entirely, or in a great measure, its pink hue, and the surface of the basin in contact with the water, will be covered with a thin coating of brown matter; in the latter, no change, or hardly any, will be remarked. The amount of deposit will be the measure of the impurities taken up and destroyed.

TO OZONISE AIR.

Dissolve a wine-glassful of Condy's Fluid (crimson) in a quart of water, add a tea-spoonful of strong sulphuric acid and mix thoroughly. On passing a current of air through this mixture by means of a pair of bellows or some more special contrivance, it will be found to possess the odour and reactions of ozone. By this means the purifying effects of Condy's Fluid, can be directly applied to aëriform disinfection.

TO PRODUCE A PERMANGANIC ACID IN THE GASEOUS STATE.

Pour a wine-glassful of Condy's Fluid (green) into a cup or jelly pot, which to prevent accidents, place in a basin, and then add all at once a table-spoonful of strong sulphuric acid. There will immediately ascend from the cup containing the mixture, beautiful crimson fumes, which are permanganic acid, set free by the violent action of the sulphuric acid on the Fluid.—*Air and Water: their Impurities and Purification.*

On Monday last, the occasion of the celebration of the twenty-first birthday of the Prince of Wales, the establishment of Mr. Ladd, at the corner of Beak Street, Regent Street, was brilliantly illuminated by means of the electric light. A revolving star of coloured light, produced by the passage of a succession of discharges from the induction coil, produced a very beautiful effect, which especially arrested the attention of the vast crowd of sight-seers.

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Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

THE ISLE OF MAN ELECTRIC TELEGRAPH COMPANY.

To the Editor of THE ELECTRICIAN.

SIR,—Referring to a paragraph in your number of the 31st of October, stating the Isle of Man cable to have been relaid; allow me to observe that this Company have as yet only been able to lift about 10 miles of their cable. While taking it up, and coming to a place where it was badly kinked, it suddenly gave way, and, up to this time, we have been unable to find the broken end.—I remain, sir, yours obediently,

P. J. DUYSHART, Secretary.

Douglas, 8 *November*, 1862.

To the Editor of THE ELECTRICIAN.

SIR,—In answer to your remarks upon the new mode of telegraphing, alluded to in the *Times* city article of the 7th inst., I beg to state, as the inventor of the apparatus in question, that messages have been transmitted by it over a distance of two hundred miles, without any intervening artificial conductor.

I have no knowledge of the experiments performed at the Government expense.—I am, sir, yours obediently, J. H.

[Our correspondent encloses his card, with name and address; but as these are not attached to the communication we cannot publish them without the permission of the writer. Our readers, like ourselves, will be anxious to hear further particulars in support of the above assertion, which—we may well be pardoned the expression—sounds almost incredible.—ED. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Although the matter may be more amusing than profitable, allow me to trespass on your space to relate an occurence which I witnessed on Saturday afternoon. Between two and three o'clock, I was crossing Threadneedle Street, just opposite that pretentious building devoted to telegraphic purposes, and observed a group of young gentlemen, standing at the corner opposite, suddenly start, as if electrified, and at the same moment, I felt a stinging sensation at the back of my head; I remarked to them in passing, that it was something very extraordinary, to which one of them replied, he thought it was from the telegraph, at the same time looking up in the air; I replied, that we did not use "*greased lightning*" as they do in America, so I did not think that the electricity could slip off the wires; one of his companions suggested that it must be peas or small shot, that some one had thrown at us. I passed on mentally reviewing the probable causes of the strange sensation, when I came to the conclusion, that as the monkeys in tropical countries, have been known to pelt, with cocoa nuts, the soldiers who retired into the shade of the woods, and removed their helmets or shakos, so, possibly, some young monkeys employed in the elaborate building, which graces the entrance to Hercules Court, not having (tails,) tales to amuse themselves with, were taking advantage of the demidial saturnalia in the city, to astonish any poor wights, who might be so foolish as to expect to do any business after two o'clock on Saturday. The occurence put me in mind of an amusing anecdote which I lately read in "Smile's Lives of Engineers," and as it may very possibly induce some of your young friends to read the whole of the work, by way of relaxation and improvement, I have taken the trouble to copy out the passage for their especial benefit, and if you, Mr. Editor, have not already read it, I think that you will give it a corner in your journal, as being an exemplification of very practical science indeed, as applied by the younger Stephenson during his boyish days.

"On another occasion he played a series of tricks, of a somewhat different character. Like his father, he was very fond of reducing his scientific reading to practice, and after studying Franklin's description of the lightning experiment, he proceeded to expend his store of Saturday pennies, in purchasing about half a mile of copper wire, at a brazier's shop, in Newcastle Having prepared his kite, he sent it up in a field opposite his father's door, and bringing the wire, insulated by means of a few feet of silk cord, over the backs of some of farmer Wigham's cows, he soon had them skipping about the field in all directions, with their tails up. One day he had his kite flying at the cottage door, as his father's galloway was fastened by the bridle to the paling, waiting for the master to mount. Bringing the end of his wire just over the pony's crupper, so smart an electric shock was given it, that the brute was almost knocked down. At this juncture, the father issued from the door, riding whip in hand, and was witness to the scientific trick just played off upon his galloway. 'Ah! you mischievous scoundrel,' cried he to the boy, who ran off. He invariably chuckled with pride, nevertheless, at Robert's successful experiments."

If the "mischievous" individuals, whose monkey tricks put me in mind of drawing their attention to this anecdote, are induced, in emulation of this great man's example, to become equally eminent through a perusal of the admirable works of Samuel Smiles, I shall feel that acts of levity, as well as the light words spoken in jest, really, are like a stone thrown into the water, producing, as it were, ripple after ripple, fainter by degrees, but still perceptible and traceable to its origin in the remotest ages.

Hoping that your journal will every week increase its power to awaken among your younger readers, a stronger interest in science, with a deeper sense of the responsibility which such attainments bring with them.—I remain, sir, yours obediently, PHILANTHROPOS.

To the Editor of THE ELECTRICIAN.

SIR,—My time has recently been so much employed, that I must crave your indulgence for another week, before I complete my communication to you.—Yours, &c. OWEN ROWLAND.

Miscellanea.

MANUFACTURE OF SALTPETRE.—Saltpetre is obtained in the Mammoth Cave, Kentucky, and considerable quantities were obtained from this source during the war of 1812. It is derived chiefly from the excrements of bats, &c. Most all the saltpetre which is employed for the manufacture of our gunpowder comes from India. It is not known whether any saltpetre is now obtained from natural sources in the Southern States. If the Secessionists were deprived of this substance entirely, they could not carry on a war. The nitrate of soda is very abundant in many parts of the world, and were it not so deliquescent, it would answer just as well for making gunpowder as nitrate of potash. The formation of natural saltpetre is a very slow process, requiring about two years to complete. During the French Revolution, 2000 tons were made in one year in Paris; and were foreign supplies cut off, twice this quantity could be made in the same space of time in the city of New York with its present number of inhabitants. In Sweden, each peasant who owns a house, is bound by law to make a certain quantity of saltpetre every year for the use of the State. In Spain, Egypt, Persia, and especially India, vast quantities of this salt are made annually; and it is not only a source of great profit but of warlike power to Great Britain.—*Scientific American.*

Telegraphic News.

TELEGRAPHS BETWEEN THE STATIONS OF THE LONDON FIRE BRIGADE.

WE hear that arrangements have been made by the London District Telegraph Company, to unite by the telegraph wire, several of the stations of the London Fire Brigade, thus enabling the Brigade to bring their forces to bear with the utmost promptitude upon any point in the metropolis where a conflagration may be taking place. It is to be hoped that when the convenience and advantage of such a system have been recognized, the same means will be generally adopted throughout England, as already they have been in several foreign cities.

STAMPS FOR TELEGRAMS.

THE London District Telegraph Company, having now the principal portion of their system in operation, embracing abont 80 stations in the principal parts of London and the Suburbs, are issuing small adhesive stamps, somewhat similar in application and appearance to postage stamps, for the pre-payment of their messages, whereby the trouble of a cash payment on each occasion of sending a message is avoided.

The stamps are available between any of the company's stations, and will doubtless in course of time, become as useful and convenient as postage stamps.

To Correspondents.

P. K.—The aërial telegraph lines erected for Messrs Waterlow and Sons, and for Her Majesty's printers, have not hitherto occasioned any accident. We fear that some of the wires, subsequently employed, have been of an inferior quality.

X.—We have no authentic information respecting the present condition of the Malta and Alexandria Cable. If the faults to which you refer actually exist, the wire will no doubt tell its own tale, at a not very distant period.

P. Q.—The alphabet for the single needle instrument, now employed by the Electric and International Company, is in harmony with the alphabet used for the Morse instrument.

O. P.—The results of the experiments are not yet known.

D. L. M.—Repeat your question in a more intelligible form.

CALLEDON.—We shall be happy to insert your article. An institution of Electricians is very desirable.

C. B.—The Indian telegraphs owe their existence to the indefatigable exertions of Sir W. O. S. Brooke. An attempt is now about being made to extend those lines towards Europe, and we sincerely trust that it will succeed, although we have reasons to complain of the efforts being involved, as usual in telegraphy, in obscurity.

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The Electrician.

VOL. III. No. 55.—NOVEMBER 21, 1862.

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ELECTRO-MAGNETIC ENGINES.

IN another portion of our columns will be found the abstract of a paper, by Mr. Robert Hunt, F.R.S., "On Electro-magnetism as a Motive Power," and of the discussion upon this paper, at the Institution of Civil Engineers. Although of somewhat ancient date, these are of no small interest, as showing the opinions entertained several years since by the engineering profession, and by other authorities, relative to the use of electro-magnetic agency as a source of motive power. We have reason to believe that these opinions have not since undergone any considerable modification, nor, indeed, can the conclusions they embody be said to be otherwise than fairly deduced from the facts which are assumed as premises. We have little doubt, however, that a different conclusion upon this important question will ultimately be arrived at, based upon other grounds than those which have hitherto been taken.

The force which, theoretically, may be assumed to be generated, under the most perfect conditions, by the solution of one grain of zinc in the DANIELL'S battery, has been given as equal to 145 foot pounds. Practically, we know that the force generated by the oxidation of a given weight of zinc is dependent upon many circumstances which may be modified, within very broad limits, to suit any particular purpose. Thus, with a given battery couple, the force may be increased by augmenting the size of the soft iron core, or by adding to the length of wire coiled upon this core, and, at the same time, increasing the diameter of the wire in an equivalent ratio. But an increased length of wire, of the same or of smaller diameter, may be used, providing we increase the difference of tensions in the elements of the couple. Instead of using copper as a negative, as in the DANIELL'S battery, we may use platinum or charcoal, thereby increasing, very materially, the force generated by the consumption of our grain of zinc. Here we appear to be stopped by the objection of expense, as applied to the batteries of GROVE and of BUNSEN. This objection, however, we need not consider as insuperable; we may apply ourselves, with some probability of success, to remove it. The substitution for the nitric acid of salts of platinum or silver, which, theoretically, might be effected with economy, is one means of overcoming the objection in question. But it has recently been ascertained that nitric acid may be employed as the "exciting fluid" for the negative element of the battery, without the necessity of a porous vessel, and *without any actual consumption of the acid*. The assertion sounds somewhat anomalous, but it is susceptible of easy explanation and verification, as we propose shortly to show. In regard to the question of comparative expenditure there remains to be considered the consumption of zinc and sulphuric acid in the battery. Our readers will, probably, have borne in mind that the zinc consumed in the battery may, with a small expenditure of fuel, be obtained from its solutions as a sulphate, by means of a compound of the earth baryta; the same quantity of which serves again and again for this purpose.* Thus the actual cost of the materials which would be consumed in the generation of the electro-magnetic force has yet to be determined. Many other points which are to be considered in reference to the present aspect of the subject treated in the paper we quote, more especially those connected with the mode of application of the magnetic force, must be reserved for future occasions. Although we do not consider that electro-magnetism will ever be brought into competition with steam as a motive power, there is every probability of its forming a useful auxiliary in certain mechanical applications.

THE TELEGRAPH AS A POPULAR INSTITUTION.

IT would be an interesting question of statistics to determine the percentage of individuals, in the metropolitan district and elsewhere, who have ever availed themselves of the means of communication afforded by the electric telegraph. There is sufficient evidence to show that the result of such an inquiry would be to establish the astounding conclusion that, to the great mass of the public, the existence of the electric telegraph as a popular institution is not only inappreciated or ignored, but practically unknown. The fact that a message may be sent, for the sum of sixpence, from one end of the metropolis to the other, or, for the sum of one shilling, "all the way" to or from Manchester, is continually dawning upon members of the general public, in the light of a novel and useful discovery, the advantage of which is fully realized when the degree of nervousness, which, in this country, appears invariably to attend the transmission of a first dispatch, has been overcome. By merely pointing out this fact —which one might suppose to be tolerably familiar to the inhabitants of the metropolis—we have, individually, on several occasions, rendered a really important service to a fellow creature. That the *naiveté* of the assertion may not give rise to any suspicion of exaggeration, we may give the details of one or two cases. The "parties" were not *city men*, who, we believe, are fully alive to the immense practical advantage of the telegraph in business matters; they belong to the large class of persons to whom the idea of using the telegraph, except in a matter of life or death, never occurs spontaneously. Our friend F. is in the Inland Revenue Office, we believe that for fifteen years he has never missed signing the attendance books at 10.15 A.M. We met him one morning sadly disconcerted and perplexed; it was necessary that he should communicate to his lawyer certain facts of importance that very morning, omnibuses were crowded inside and out, no trusty messenger could be found, and the prospect of an early attendance at Somerset House appeared out of the question. We suggested the telegraph, which had never entered his thoughts. Where was there an office? Not three minutes walk from the spot. The charge? Sixpence. His first message was forwarded; and since that period he has frequently employed the telegraph wires. Another example relates to a different species of the class to which we have referred. DUSTERLEY, who, with his wife, has the charge of a certain set of offices in the city, may be brought forward as the representative of a predilec-

* Vol. 1, p. 85.

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tion which prevails to a far greater extent in America than in England, and in which, we may freely confess, we share to a certain extent. He patronises and approves of the telegraph, because it saves him the trouble of inditing his epistles with pen and ink. He possesses the talent of concise rather than of elegant expression, and the small extra expense of the telegraph, over that of the post office, is more than counterbalanced, in his case, by the saving of time and labour in composition. Formerly, every item of correspondence necessitated an excursion for the necessary stationery and stamp, a serious consultation of the married people as to the correct form and expression, and, after the use of a steel pen in puncturing and abrading the paper, a fresh excursion to the post office. On one occasion we gave him a franked form for a telegram, and we find that he has since invariably preferred the telegraph to the post office in correspondence, noting his subject matter in pencil, and delegating all further responsibility to the telegraph operator.

The main difficulty in popularising the telegraph is to get people to send their first message. While we find that but few of those with whom we come in contact have ever sent or received a message; we also observe that of these few scarcely any have failed to extend their acquaintance with the telegraph. We believe that it was proposed, at the time when the London District Telegraph Company was established, to throw open the offices to the public, gratis, for a certain space of time. It is probable that this course would have resulted in a solid and permanent advantage to telegraphy. The telegraph would have become a really familiar marvel; and familiarity would certainly, in this case, not have engendered contempt. It is difficult to analyse the feelings which prevent so many from trusting themselves inside a telegraph office. The fear of "covert insolence" from "beardless boys," which has recently been so humorously referred to by *Punch*, is more suppositious than real, and cannot apply where female operators, invariably found to be courteous and obliging, are employed. The fact that a telegraphic message often produces upon the receiver the effect of a deep-bordered mourning envelope may be, to some extent, an objection, and can only be completely removed when such missives are of more frequent occurrence. But the British public is ever distrustful of novelties, even when these have reached to a tolerably mature period of existence; and long experience has taught that the "price marked in the window" is not always worthy of implicit credence. Time is perhaps the only cure for such misgivings, and we are glad to observe that it is operating slowly but surely to remove them. Indeed, the word "slowly" must be taken in a comparative sense, as will be seen by the following summary of the receipts and number of messages of the London District Company, from the commencement of the undertaking:—

Half-year, ending.	Gross.	Nett.	No. of Messages.
	£ s. d.	£ s. d.	
June, 1860	751 11 0	550 19 11	26,115
December, 1860 ...	1,547 12 9	1,058 19 2	47,365
June, 1861	3,232 11 4	2,137 1 7	64,785
December, 1861 ...	4,147 1 4	2,592 15 10	77,939
June, 1862	6,513 18 4	3,956 4 8	123,280

The following table, taken from a blue book, entitled "Miscellaneous Statistics of the United Kingdom" (1861), will show the progress made by the other telegraph companies, from the year 1858 to 1860, inclusive:—

Telegraph Companies.	Length in Miles of Telegraph Lines.			Length in Miles of Wires used.			Number of Stations open for the Public.		
	1858.	1859.	1860.	1858.	1859.	1860.	1858.	1859.	1860.
Electric and International *	6,103	6,272	6,541	30,733	31,346	32,148	517	428	476
British and Irish Magnetic †	3,656	3,719	3,768¾	16,532	16,595	16,661	327	382	386
South-Eastern Railway ‡	308	308½	308½	1,486	1,548½	2,087½	84	87	88
London, Brighton, and South-Coast Railway	119	123½	162½	239	247	325	25	29	30
Total	10,186	10,423	10,780¾	48,990	49,706½	51,221¼	953	925	980

	Number of Instruments.			Number of Public Messages.		
	1858.	1859.	1860.	1858.	1859.	1860.
Electric and International	3,024	3,194	3,352	870,143	1,025,269	1,117,364
British and Irish Magnetic	854	923	1,073	406,608	549,880	608,332
South-Eastern Railway	133	129	133	37,394	43,156	48,897
London, Brighton, and South-Coast Railway	74	82	114	6,941	11,425	14,664
Total	4,085	4,338	4,672	1,321,086	1,629,730	1,789,257

Should this rate of progress be maintained, as it hitherto has been, we may look forward with certainty to the telegraph becoming, in England as in America, a really popular institution.

* On the 1st of January, 1859, this Company had 85 Agreements with Railway Companies and Public Offices for their Business Messages. The number of such Messages is not recorded, but is estimated as amounting to three times the number sent by the general Public. This Company also furnished intelligence in January 1859, to 180 Provincial Journals, and to 70 different Reading Rooms, but no record is kept of the number of those Messages.

† The number of Messages to and from the Continent transmitted jointly by this Company and the Submarine Telegraph Company, and the number of Messages for Railway Companies, Newspapers, and News Rooms, are not included with the Messages for the Public, but are estimated at about 250,000 Messages per annum.

‡ The South-Eastern Railway Company has no working arrangements with either of the Electric Telegraph Companies.

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ANOTHER DISCOVERED CASE OF WILFUL DAMAGE TO A SUBMARINE CABLE.

It will be recollected that some time ago, a submarine telegraph cable was wilfully damaged, by driving a nail through the outer iron wires, and so destroying the insulating material, rendering one of the conductors entirely useless. That this was not an isolated instance of a submarine telegraph cable having been most maliciously injured, the following will show ;—

The Hanoverian, (Emden) cable belonging to the Submarine Telegraph Company, was laid by the contractors in 1858, and during its submergence, when more than half way towards the island of Borkman, a considerable loss of insulation was observed, and the cable was buoyed, in order to be able to return to the spot, if necessary, when the whole length was laid and the end landed.

When the paying out was completed, and the telegraph instruments attached on shore, it was found that both wires were workable, and an arrangement was concluded between the contracting parties for it to be repaired at the manufacturer's expense, should it be found requisite to do so within twelve months.

The year expired, and both conductors were still at work. In the fall of 1861, however, one of the wires showed great leakage, and was seldom used on account of the difficulty experienced in regulating the relays.

In consequence of this, the Directors of the Submarine Telegraph Company determined the repairs should be undertaken at the first appearance of fine weather.

On the 15th of June last the company's engineer left with a steamer, for this purpose, and reached the Dutch Coast on the 19th. The weather, instead of proving fine, as might be anticipated at that period of the year, was on the contrary most boisterous, and up to the 10th of August, when the fault was cut out, there were but seven days, and those not the fittest, in which is was possible to handle the cable.

Great difficulties had to be encountered, on account of its having become deeply imbedded in the sand, off the Dutch Islands, at the place where the fault was found. Sometimes the cable had to be abandoned and grappled for some hundreds of yards away, at others it was only possible to get it out of the sand at the rate of 15 or 20ft. an hour. The position of the fault was at last reduced to within a length of six feet, which piece was cut out, kept intact, and handed over to the Secretary in London, so that it might ultimately be carefully examined, and a fresh length of new cable was spliced in its place, since which operation the working of the cable has been most satisfactory.

Sir James Carmichael, Chairman of the company, some of the Directors, and Mr. France, the company's engineer, together with Messrs. Glass, Elliott, and Cannning, were present at the examination of these two yards of cable, which had caused so much anxiety and loss to the company. Exteriorly, no fault could be found, but, on minute inspection, a slight indication of rust was observed between two of the outer wires, caused, as might be imagined, by the removal of the tar, by the abrasion of the implement used in making the puncture. The iron wires were then carefully removed, and at this particular spot it was found a sharp instrument, such as a sailor's knife, had been forced through the iron wires, severing the hemp serving, penetrating and cutting through the gutta percha to the copper of one wire; the incision on the other not being quite so deep, proving, beyond question, the malicious origin of the injury, which must have been done either during the manufacture or at the laying down of the cable.

The reason of this fault resting dormant so long, was owing to the serving of tarred jute, closing under the pressure of the protecting iron wires of the sheathing on to the gutta percha, it requiring some considerable period, during which the cable was worked, to elapse before the current forced its way through this artificial insulation.

The damaged core is sealed up again and placed in the hands of the Secretary.

ELECTRO-MAGNETIC ENGINES.

The following is an abstract of the paper of Mr. Robert Hunt, F.R.S., "On the application of Electro-magnetism as a Motive Power," read before the Institution of Civil Engineers, April 21, 1857, and of the interesting discussion which took place on that occasion :—

The author commenced by giving the progress of the investigations by which Oersted first proved the connection between electricity and magnetism, and which led Sturgeon to construct the electro-magnet. The powers of this form of electric force, as developed temporarily in soft iron, natu- induced the idea of employing it for the purpose of exerting mechanical motion—*doing work*. The principles of the electro-magnetic machines of Dal Negro, of Botta, of Jacobi, of Armstrong, of Page, and others, were next described. It was shown that all engines acting by a direct pull were inefficient, from the circumstance that the repeated blows received by the iron so altered its character, that it eventually assumed the quality of steel, and had a tendency to retain a certain amount of permanent magnetism. This induced Jacobi, after a large expenditure of money, to abandon arrangements of this kind, and to employ such as would at once produce a rotary motion. The engine, thus arranged, was stated to have been tried upon a tolerably large scale on the Neva ; and by it a boat, containing ten or twelve people, was propelled at the rate of three miles an hour. Page's engine, and that of Hjorth, which, in 1851-52, excited much attention, was described as being, in principle, an electro-magnetic piston drawn within, or propelled from, an electro-magnetic cylinder. By this motion it was thought that a much greater length of stroke could be secured than by the revolving wheels or discs. After having generally described the forms under which electro-magnetic engines had been constructed, the author proceeded to give, as the result of his experiments, confirmed by those of others, the difficulties which still stood in the way of the application of electricity as a motive power.

In the first place, it was pointed out that the loss of power through space was very great, and that the lifting power of any magnet was not to be regarded as the power it was capable of exerting at a distance from its poles, however short that distance might be.

In the second place, it was shown that—supposing the reduced force exerted by two magnets, a few lines apart, was considered available for driving machinery—the moment the magnets began to move in front of one another there was again a great additional loss of power. As the speed of the engine increased, there was, curiously, a corresponding diminution of available mechanical power, a falling off in the *duty* of the engine as the rotations became more rapid.

In the third place, the conditions of the voltaic battery were considered, the generation of electricity was dwelt on, the mode by which it passed from one plate in a series to another, and the loss of power consequent upon the resistances in passing from a solid to a fluid, and again from a fluid to a solid, was explained. It was insisted that, under any circumstances, with the present forms of the voltaic battery, it was useless to attempt to utilise, in this direction, the chemical electricity generated. All study should be directed to the development of electricity by chemical action, so as to secure, if possible, the whole of the electricity developed by every change of form in matter. More emphatically the author endeavoured to enforce the law, that all mechanical force, of whatever kind, whether horse or man power, steam power, or electrical power, involved a change of the forms of matter, to produce that force. That to produce motion it was essential to use matter, and that virtually, in all cases, it must be destroyed as a useful agent. Thus, that a man or horse moving a weight consumed muscle equivalent to that weight, and the space through which it moved. That a steam engine drawing a train, pumping water, or impelling any machinery, consumed, in the production of steam, a quantity of fuel exactly representing the work done. That in producing motion by electricity, the element changing its form to produce that motion was one of the solid agents employed in the battery, and the exciting fluid element used.

An equivalent of matter, in changing its form, would produce an equivalent of force, which might be rendered available ; but as there was a constant relation between the chemical combining proportion of any element, and its capability to produce mechanical power, the question of the application of electricity, as a motive force, was narrowed to the inquiry into the quantity of power produced relatively by fuel in the furnace, and by zinc or iron in the battery. It had been proved by experiment, that six grains of carbon in the fuel produced a motive power equal to thirty-two grains of zinc in the battery ; and that, under the best possible conditions , an equal result would be secured by the combustion of six pounds of anthracite coal—the most carbonaceous fuel—as by the conversion in the battery of thirty-two pounds of zinc into oxide. Another and a parallel form of putting the case was, that the thirty-two pounds of zinc burnt in the furnace would develop precisely the same quantity of heat as that which would be obtained from burning six pounds of charcoal in the same furnace. That, whether producing heat during combustion, or electricity during chemical change, the mechanical force obtained would be precisely the same. Hence the commercial question of cost was greatly in favour of steam, and adverse to the use of electricity as a motive power.

In commencing the discussion, it was remarked, that Mr. Joule's researches on the subject appeared not to be sufficiently known to either theoretical or practical men.

In a series of papers, in the "Philosophical Magazine," that gentleman had shown, by an able combination of theory with experiment, what the total mechanical effect, derivable from the consumption of a stated quantity of zinc, in any of the ordinary galvanic batteries, amounted to ; and, in conjunction with the late Dr. Scoresby, he constructed an electro-magnetic engine, driven by Daniell's battery, which actually performed more than fifty per cent. of the whole theoretical duty. The theoretical duty of a grain of zinc, used in a Daniell's battery, was 145 foot lb. Now the engine referred to actually performed 80 foot lb. of work per grain of zinc consumed, or 54 per cent. of the full duty. Among other conclusions that might be drawn from these experiments was this : that until some mode was invented of producing electricity as many times cheaper than that of an ordinary

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galvanic battery as coal was cheaper than zinc, electro-magnetic engines could not supersede the steam-engine. For, supposing an electro-magnetic engine to perform 75 per cent. of the theoretical duty, instead of the 54 per cent. obtained by Joule, then such an engine, as near perfection as could be reasonably expected, would use 5 grains per second, or 26lb. per hour of zinc, per horse power. A perfect electro-magnetic engine, driven by a Daniell's battery, would use 2 lb. of zinc per hour, per horse power. Some of the best steam-engines would perform 143 foot lb. of work, per grain of coal, or would use 2 lb. of coal per hour, per horse power. In a scientific point of view the electro-magnetic engine was stated to be most interesting, as having been the means of solving the problem of converting a large per centage of the whole energy of chemical forces (those of combination of zinc with oxygen and acid) into mechanical effects, without letting it into the form of heat at all, making in fact the combustion of zinc not generate more than 46 per cent. of its equivalent of heat, and directing it to raise weights with the remaining 54 per cent. of its energy. But this very circumstance took away from its practical importance, since it showed how little could be expected from electro-magnetism, more than had been done by Joule and Scoresby. On the other hand, Joule's theory showed that the full theoretical duty of the combustion of the coal was about eight times as much as had been obtained in the best steam-engines, and left a very wide margin for improvement in engines, deriving mechanical effect from coal fires. It ought, however, to be added, that although steam-engines fell so far short in the duty they rendered for the consumption of the coals, the best steam-engines did, in reality, perform 50 or 60 per cent. of the duty of a perfect engine, taking in heat at the actual temperature of their boilers: and that to attain more than double, or even to attain as much as double the present economy of a good steam-engine, it would be requisite to introduce engines taking in heat at a much higher temperature than the highest of the actual high-pressure boilers.

It was explained that the author's knowledge of this subject, was founded on an extensive series of experiments which he had made at Falmouth, for the Russian Imperial Commission, as well as on another series, made subsequently, at the request of some gentlemen connected with the copper trade of the port of Swansea, on both of which occasions he had arrived at the conclusion that it was only at an enormous cost that electro-magnetism could be applied as a motive-power. It had been stated that it might possibly be advantageous to employ this power in ships engaged in the copper trade with South America, even if the cost was thirty times as great as steam power in this country.

It was remarked, that Professor Botto, of Turin, had estimated that with Grove's battery there would be a consumption of 45 lb. of zinc per H.P. per day. Starting with this, and assuming a battery of one cell, the equivalent of zinc being 32, and one-third of an equivalent of nitric acid being 18, there would be consumed for 45 lb. of zinc, 25·3 lb. of nitric acid, equal to about 50·6 of commercial acid. Taking the zinc at threepence per lb., and the nitric acid at sixpence per lb., and setting off the small quantity of mercury used for the amalgamation, and the sulphuric acid against the salts formed, the estimated cost would be 1*l.* 16*s.* 10½*d.* per H.P. for every twenty-four hours. Then came the theoretical difficulty of the equivalents of power. The idea was, that the same quantity of matter being changed, would produce—if all the force could be utilised—the same amount of power, so that, theoretically, whether a pound of zinc was employed, by burning under a steam-engine, or in decomposed water, and then exploding the gases, or in turning an electro-magnetic machine, the result would be identical in each case as to the amount of power obtained. Then there was the difficulty, not only of employing zinc, but also other materials—sulphuric acid, for instance, which was the cheapest; all these went through a costly process before they could be employed for these purposes. Thus manufactured, and consequently expensive materials were used, instead of a crude matter. Therefore, unless the power could be utilised to a greater degree than in the steam-engine, the difficulty was apparently insuperable. With the present form of magnets it was believed that those powers could not be utilised to the requisite extent. The main advantage, in using this kind of power, was due to the fact that the instant the machine ceased working, the expenditure of power also ceased, and it was not until the power was again applied that any consumption of material occurred, and then only according to the work performed. This advantage was not, however, sufficient to compensate for the disadvantage of having to use 50 or 60 parts of manufactured materials for the production of force, instead of 6 parts of crude matter. If electricity could be obtained from coal and water, or from coal and air, the problem would be solved. It was known that an electric current could be obtained by the combustion of charcoal, or from flame, but the utilisation of such combustion was far distant, so as to convert its force entirely or substantially into an electric current, although an infinitesimal portion of that form of force could be obtained from the burning of fuel. Practically speaking, coal had not hitherto, in any form, been made to act as the positive element of a battery. It had been imagined that the difficulty might arise from carbon forming a compound with two equivalents of oxygen, which was not electrolytic, or practically soluble, and this idea was partly corroborated by the discovery that carbon acted better as the positive element, in an alkali, as potash, or soda, where the carbonic acid would be immediately absorbed, than in an acid solution; but the current with an alkali was feeble.

The great desideratum was considered to be, not so much the form of the machine, as improvement in the source of the power itself, the battery, or furnace. The forms of machines might be divided into three types. First, there was the principle of suspension, or making or stopping the magnetism followed in the machines of Dal Negro and of Botto; second, the principle of the 'inversion of polarity,' adopted by Richie and followed by Jacobi; and third, the deflecting, or galvanometer principle, where the needle was deflected with a coil round it. This was first practised by Petrie. All the larger machines which had been constructed, were on the suspension, or the inversion principle, the latter being thought to be the best. The boat referred to by the author was worked upon the inversion principle, and in it three persons had travelled at a rate of three miles an hour, but the expense put it out of the question as a practical application. At present electro-magnetism must be confined to special purposes, where the danger of steam and the creation of vapour were sought to be avoided, or where economy of space was a consideration. But it was far removed from general application as a motive power.

It was thought that the shape of the magnet might be altered by widening the poles, so as to have a still slower diminution of the forces. The alteration of the force of the current, by the motion impressed upon the apparatus, was thought to be due to the generation of induced currents, whose action was opposed to the primary current, and therefore lessened its power. It was suggested to envelope the electro-magnet in a closed coil of wire, not in contact with the battery, which coil, when the motion was set up, should have an induced current formed in it; this induced current might then be carried to a second electro-magnet and wound round in a manner so that the current should assist the primary magnet. The relation between heat and mechanical effect was a subject of great practical importance, both to the man of science and the practical engineer, and it was suggested that experiments of so momentous a character should not rest on the unsupported testimony, valuable as it was, of one individual, but that another series of independent experiments should be instituted so as to place the question beyond doubt.

The results obtained from various machines were mentioned. One with a fixed horse-shoe electro-magnet, and a revolving straight bar electro-magnet, and driven by a single cell of Daniell's battery, raised 3lb. one foot high in a minute, with the consumption of one ounce of zinc in eight hours. A considerable advantage was derived from making the revolving bar of several thin plates of iron, instead of making it solid. It then received and parted with the magnetism more rapidly. The commutator was made of silver, to avoid oxidation, and the sparks were suppressed, by causing the rubbing wires to touch one segment of the commutator before leaving the adjoining one. A bobbin and fly had been driven, and cotton had been spun by this machine.

A larger machine, with several magnets, produced less power. In the first machine the magnetism must have been reversed in less than one thousandth of a second, otherwise the machine could scarcely have produced any power at all.

Another machine was described, in which a cranked, or eccentric iron shaft, was alternately attracted by two electro-magnets, or two pair of electro-magnets. This machine ran 4,000 revolution per minute unloaded, and from 1,800 to 2,600 revolutions per minute with the best load. It raised 21lb. one foot high in a minute, with six Smee's batteries.

Another machine, consisting of an iron clutch, or toothed disc, wound with copper ribbon, and revolving over a similar fixed clutch, or disc, raised 21lb. one foot her minute, with two of Lemolt's nitric acid and carbon batteries.

These results tended to show that the cost of electro-magnetic power was enormous, in proportion to steam power. It was suggested as probable that one atom, or chemical equivalent, of zinc, consumed or oxidised, in driving a perfect electro-magnetic engine, would not produce more power than one atom or chemical equivalent of coal consumed or oxidised in driving a perfect steam engine; while the cost of the equivalent of zinc was two or three hundred times that of the coal.

It was observed that in all forces the primary change of matter, or the new attraction set up to produce the phenomena which were manifested, must be regarded. In the steam engine, the source of power was the attraction which was created between the coal and the oxygen of the atmosphere. In the battery, it was the attraction between the zinc and the oxygen of the water. It was considered that the most perfect results, with regard to the primary changes, were obtained with the voltaic battery, because, in a well-constructed instrument, the initial change, which took place to produce the power, could be used with a very small per centage of waste. Theoretically, battery power ought to be had at a profit, but it was difficult to find a market for the sale of the sulphate of zinc, though it might be different when it was produced in large quantities, as in the preparation of the plates of the Ordnance Survey, where the sulphate of zinc had been sold, and had become a matter of consideration in a commercial point of view. When, however, the cost was taken into account, the difference was greatly in favour of coal as a source of power. The use of hydro-carbons had been tried for the positive poles of a battery, but they were not practically efficient. It might be taken as a fundamental principle that, up to the present moment, zinc was the best material for the purpose. Where batteries were employed, they exceeded, it was believed, every other mechanical force in two things. The first was the great distance at which it could be applied; and the second, that, when once set at work, the battery would continue in operation over a long period of time. Although motive power could not be produced at the same expense on a large scale by the agency of the battery, as it could with coals, yet the achievements of the electric telegraph might be regarded as an

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application of motive power by electricity which was by no means to be despised. The fall of the ball at Deal, by which the chronometers of the mercantile navy were regulated, and also the means of regulating the time at the General Post Office, the Great Western Railway Station, the Telegraph Office, West Strand, &c., were due to this cause.

It was stated that the object in view in constructing a machine for deflective action was to get rid of the short distances over which the power acted, in the case of ordinary electro-magnets. Success had so far attended these efforts, that the deflective action had been extended to one foot, instead of only a fraction of an inch. A pressure of about 18 lb. had been obtained round a surface twenty inches in diameter, but that was reduced directly it was allowed to attain any velocity. The reduced current was the cause of this great reduction of force, and in proportion to the motion so was the action of the reduced current increased. It was believed that the cost of the nitric acid, in the estimate which had been given in the early part of the discussion might be omitted, as it could be reconverted by a single process.

A comparison which had been instituted as to the cost of different means of producing power, showed that for every shilling expended there might be raised by—

Manual power	...	...	600,000 lb. one foot high in a day.
Horse ,,	...	...	3,600,000 lb. ditto
Steam ,,	...	...	56,000,000 lb. ditto
Electro Magnetism		...	900,000 lb. ditto

It was explained that the results recorded in the paper as to the diminution of magnetic force through space were the mean average results actually obtained from a number of experiments with magnets of various forms, some having long and others short arms. The plan of winding round the magnet a closed coil of wire not connected with the battery, the induced current in which might be employed to produce magnetism in another bar of iron, had been tried by Hjorth and had been abandoned, owing to the difficulty of dealing with the current when the magnet was in motion. It had also been found that the power from the second magnet thus created was of very inferior moment in any form of machine then devised, and was not practically available.

With regard to the relation between heat and mechanical effect it was remarked that the experiments of Joule had been confirmed by the researches of Professor William Thompson, of Glasgow—that Dr. Scoresby worked with Joule on this problem—that it had engaged the attention of Professor Bunsen, of Marburg, and more recently of M. Favre, who had arrived at the same conclusions as those recorded by Joule.

It was regretted that in France the delusion as to the possibility of electro-magnetic engines superseding steam still prevailed. Fifteen years ago it had been proved, experimentally, that the heat evolved by any voltaic circuit in which an engine was not included, was exactly that due to the chemical actions taking place, the conducting wire merely presenting the means of evolving the heat in any given locality, instead of it being all evolved where the chemical action took place. This discovery, which had been erroneously attributed to M. Favre, whose experiments were only three years old, was followed up by the discovery—that if an electro-magnetic engine be placed in the voltaic circuit, the heat evolved, corresponding to a certain chemical action, was diminished, the heat which appeared being converted into the mechanical force given out by the engine. The greater the quantity of heat which disappeared from the voltaic circuit, relatively to the heat due to the chemical actions, the more perfect would be the economy of the electro-magnetic engine; and as it was possible to make the engine work so as to reduce the intensity of the current to a very small fraction of its strength, when the engine was not working, nearly the whole of the heat due to the chemical actions of the battery might be evolved as work. Supposing all of it were converted into work, there would result 145 foot lb. for each grain of zinc consumed in a Daniell's battery. It was the weakness of the chemical actions of a voltaic pile, as compared with that of the combustion of coal, and the relative cost of zinc and coal, which decided so completely in favour of the steam-engine. As regarded the strength of the chemical actions, one grain of zinc consumed in a Daniell's battery gave out heat equivalent to 145 foot lb.; but one grain of coal burned in air produced heat equivalent to 1,261 foot lb., or nine times as much; so that if a steam engine was so bad as to convert only one-ninth part as much heat as the electro-magnetic engine, the two would still be on a par. As to expense, it was obviously impossible that the cost of coal could ever become more than a minute fraction of that of zinc, to say nothing of that of other necessary materials.

It was observed that those who had hitherto attempted the solution of the problem of electro-motive power, seemed to consider that the whole question resolved itself into producing a certain amount of electricity at a given cost. The chemical question, in fact, was first considered, instead of the mechanical application of a given force. Magnetic force died rapidly away through but a short space. If the geometrical curve of the dynamic force of magnetic attraction was drawn, and was divided into ten parts, then it would be found that if the tenth nearest the magnet gave a mean power equal to 1,000 lb., the mean force of the tenth part furthest from the magnet would only be 3 lb., though the same amount of electricity would be used in the one case as in the other. Taking the mean of the whole attraction of a magnet, only a small power was obtain through a short distance. In Jacobi's engine, in which the rotary principle was adopted, the minimum portion of the magnetic attraction only was applied, giving but a small power with a large consumption of electricity. In another electro-magnetic engine, in which a different form of magnet, with four, six, or eight poles placed upon a plate had been adopted, it had been endeavoured to apply the maximum portion only of the dynamic force; and this, by a succession of magnets, was successively and continuously brought into action, giving a comparatively large power, with a small consumption of electricity, and producing in a machine a continuous motion analogous to the overshot water-wheel.

It was hoped that, though apparently impracticable now, in process of time electricity might be applied as a motive power. For when it was considered what had taken place with regard to electricity, how, in the first instance, it had been obtained from friction upon amber, or glass, was then developed by chemical action from metals—and was subsequently manifested by the influence of heat on solid bodies, as shown in the form to which the name of thermo-electricity had been given—it was felt that a series of industrious researches into the undeveloped secrets of this marvellous element might result in a means of producing the power which would render it as economical and advantageous as the heat which was now obtained so easily. It was only a few years since Sir Humphrey Davy was compelled to employ a thousand pairs of zinc and copper plates, to do the work which twelve of the same agents would perform in a modern battery.

It was thought that the subject under discussion ought to be divided into two distinct parts—first, the mode of producing electricity, and second, the apparatus to which such electricity was to be applied. If possible, the natural products to be found in the earth ought, for the sake of economy, to be employed in both cases instead of products manufactured at considerable cost. It was remarked that, hitherto, electro-magnetic engines had not been constructed in accordance with a power varying inversely as the square of the distance, for which certain remedies were suggested. It was also recommended that a modification of the waves of contraction in muscular fibre should be adopted in electro-magnetic engines. Allusion was made to certain peculiarities common both to muscular fibre and to the electro-magnet, and attention was particularly directed to sound, which was developed in both, on the production of a pulling power, and to both being a substitute for nervous energy. Electricity could be used either directly by means of the electro-magnet, or indirectly by the explosion of gases. Heat, electricity, electro-magnetism, magnetism, and pulling power were all only different manifestations of one and the same force, and each was convertible into any other. The mechanical effect of a flash of lightning was analysed, and it was shown that, in a certain instance, the power developed through fifty feet was equal to a 12,220 H.P. engine, and that the initial explosive power was equal to a pressure of three hundred millions of tons. The desirability of obtaining a motive power requiring less weight per H.P. than the steam engine, was then adverted to, and reference was incidentally made to some experiments which had been tried at different times with this object in view. In this way it had been ascertained that the motive power derivable from the chalk formation near London would cost four times more than that obtained from coal. The power to be derived by the production of the vapour of a volatile spirit by the condensation of steam—from the explosion of a mixture of hydrogen and oxygen by electricity—from the condensation of the vapour of a highly volatile spirit by ice—and by a certain quantity of solid hydrogen and oxygen, by means of the steam engine and by means of the muscle of the horse, were then adverted to; and it was stated that the latter gave out nearly ten times as much power as the most perfect present arrangement of the steam engine in Cornwall.

In closing the discussion it was remarked that there could be no doubt, from what had been said, that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. Without, however, considering the question in that point of view, the mechanical application seemed to involve almost insuperable difficulties. The power exhibited by electro-magnetism, though very great, extending through so small a space as to be practically useless. A powerful magnet might be compared, for the sake of illustration, to a steam-engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable.

In the mechanical application of power, velocity, or, in other words, the space passed over, was made as large as possible, and in proportion as this was accomplished had the efficiency of the machine been extended. Now, this was precisely the difficulty under which the application of magnetism laboured—the space through which it could be made to extend being so exceedingly small.

SOLUBLE GLASS.

THE following, is the method given by Fuchs, for the preparation o soluble or "water" glass:—Fifteen parts of powdered quartz are ignited, with ten parts of crude potassa, and one part of charcoal, (which decomposes and expels the sulphuric acid contained in the potassa), till perfect vitrification takes place. The hard, blistered, greyish, black mass, thus obtained is pulverised, then boiled with five times its weight of water, (which dissolves it slowly, but almost entirely, in the course of four hours) and the solution is finally evapo-

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rated. If the residue, on evaporation, be heated till it fuses, it loses water, and becomes a hard transparent, rather fusible, glass, which on exposure to the air, absorbs so much water, that it swells up strongly when heated. The substance obtained by simply drying the solution, is colourless, transparent, and brittle, with a conchoidal vitreous fracture, but softer than glass. It has a slightly alkaline taste and reaction, and, after thorough drying, contains 36 per cent. of potassa, 62 of silica, and 12 of water. The salt is permanent in the air; does not absorb carbonic acid from it: and effervesces only when accidentally mixed with other salts of potassa. In the fire it swells up with loss of water, then fuses, and forms anhydrous soluble glass. Dilute acids decompose it, with separation of silica, more easily than concentrated acids. It dissolves, but very slowly in cold, but readily in boiling water.

A concentrated solution containing 28 per cent. of anhydrous soluble glass, is syrupy, tenacious, somewhat turbid, and of sp. gr. 1·25; on boiling, or on exposure to the air, it becomes covered with a tough skin, which disappears when thrust beneath the liquid. After evaporation at a high temperature, it becomes very tenacious, and may be drawn out into threads like melted glass. It dries up to a varnish when spread upon wood &c, the combustibility of which it dimenishes. A dilute solution absorbs carbonic acid from the air, a concentrated one, scarcely at all.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1784—ADAMS, George.—

[An Essay on Electricity, in which the Theory and Practice of that useful science are illustrated by a variety of experiments arranged in a methodical manner. To which is added an Essay on Magnetism. By George Adams, Mathematical instrument maker to his Majesty. London: Printed for and sold by the Author, at Tycho Brahe's Head, No. 60, in Fleet Steet, MDCCLXXXIV.]—8vo., plates.

1785—FRANKLIN, B., and others.—

[Report of Dr. Benjamin Franklin, and other Commissioners charged by the King of France with the examination of the Animal Magnetism as now practised at Paris. Translated from the French with an Historical Introduction. London: Printed for S. Johnson, No. 72, St. Paul's Church Yard, 1785.]—Pam., small 8vo.

1785—VAN MARUM, Martimus.—

[Description d'une très Grande Machine Electrique placée dans le Muséum de Teyler a Haarlem et des Experiments faits par le moyen de cette Machine. Par Martimus Van Marum, &c. A. Haarlem. Jean Enschedi et fils et Jean van Walré, 1785.]—4to. 266 pages, plates.

This book is written in French and Dutch, therefore it is only equal to 133 pages of an ordinary work.

1785—DE BRUNO.—

[Recherches sur la direction du fluide Magnetique, dédiées a Monsieur Frere du Roi. Par M. De Bruno. Introducteurs des Ambassadeurs pres sa personne. A Amsterdam et se trouve a Paris. Chez. Gueffier, Imprimeur au bas de la rue de la Harpe, a la liberté, MDCCLXXXV.]—One volume, 8vo. Numerous interesting plates of the magnetic lines of force

1787—LOUNDES, Francis.—

[Observation on Medical Electricity, containing a Synopsis of all the Diseases in which Electricity has been recommended or applied with success; likewise pointing out a new and more efficacious method of applying this Remedy by Electric vibrations. By Francis Loundes, Medical Electrician. London: Printed by D. Stuart, Exeter Street, Strand, for the Author; and to be had of all booksellers, MDCCLXXXVII.]—8vo., Pam., 51 pages.

1787—BERTHOLON, Abbé.—

[De l'Electricité des Meliors ovrage dans lequel on traite de Electricité Natural et general et des Meteores en particulier: contenant l'exposition and explication des principaux phenomenes que ont rapport á la Meteor ologie Electrique d'apres l'observation et experience avec figuers. Par M. l'Abbe Bertholon, professeur de physique experimentale des Etats-Genereaux de Languedoc, des Academies Royales des Siences de Montpellier de Lyon, Bordeaux, Dijon, Beziers, Marseille, Nîmes, Rouen, Toulouse, Valance, Madrid, Rome, Hesse Hombourg, Lausanne, Florence, Milan, &c. &c. A Paris. Chez Croullebois, rue des Mathurins pres celle de la Harpe, MDCCLXXXVII. Avec approbation et privilege du Roi.]—Two vols., small 8vo., illustrated.

1787—? NAIRNE.—

[The Description and use of Nairne's Patent Electrical Machine; with the addition of some Philosophical Experiments and Medical observations. London: Printed for Nairne and Blunt, No. 20, Cornhill, MDCCLXXXVII.—Pam., 8vo., 68 pages, plates.

1787—HAUY, M. l'Abbe,—

[Exposition raisonnée de la Theorie de l'Electricité et du Magnetisme, D'apres les principes de M. Æpinus, des Academies de Petersburgh, de Turin, &c. Par M. l'Abbe Haüy. De l'Academie Royale des Sciences. Professeur Emérete de l'Université. A Paris. Chez. la veuve Desaint, libraire Rue du Foin, Saint Jacques, MDCCLXXXVII.]—8vo., 238 pages, plates.

1788.—PREVOST, P.—

[De l'origine des forces Magnétiques. Par P. Prevost. De l'Academie Royales des Sciences et Belles-Lettres de Berlin, et Professeur Honoraire à l'Academie de Genève. A Genève. Chez. Barde, Manget et Compagnie. Imprimeurs, Libraires, et se trouve a Paris chez Buisson, Libraire, rue des Poitevins, hôtel de Mesgrigny, MDCCLXXXVIII.]—Small 8vo., plates.

1788—RIBRIGHT, Thomas.—

[A curious collection of experiments to be performed on the electrical machines made by Thomas Ribright, Optician to his late Royal Highness *George*, Prince of *Wales*, at the King's Arms, No. 40, in the Poultry, London, with practical rules for the use of the electrical apparatus, and for performing experiments. The second edition enlarged and improved. London: Printed by H. D. Steel, No. 51, Lothbury, MDCCLXXXVIII.]—Pam. 2 plates.

1789.—MEREDITH, Nicholas.—

[Considerations on the utility of conductors for lightning; in which the nature and properties of the lightning are explained, and the admirable uses of the conductors in preventing its calamitous effects clearly pointed out. By Nicholas Meredith, Optical and mathematical in-

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strument maker to his Royal Highness the Duke of York. London: Printed for and sold by the Author, No. 91, New Bond Street: and by J. Mathews, No. 18, Strand, 1789.]—Pam. plate.

1789—Bennet, A.—

[New experiments on Electricity wherein the causes of Thunder and Lightning, as well as the constant state of Positive or Negative Electricity in the air or clouds, are explained; with experiments on clouds of Powders and Vapours artificially diffused in the air. Also a description of a doubler of Electricity, and of the most sensible electrometer yet constructed, with other new experiments and discoveries in the Science; illustrated by explanatory plates. By the Rev. A. Bennet, F.R.S., Curate of Wirskworth, Derbyshire, Derby: Printed by John Drewry, MDCCLXXXIX,]—8vo., 141 pages, plate.

1789—Brook, A.—

[Miscellaneous experiments and remarks on Electricity, the Air-pumps, and the Barometer; with the description of an electrometer of a new construction: illustrated with copper-plates and notes. By A. Brook. Norwich: Printed by Croun and Stevenson, for J, Johnson, No. 72, St. Paul's Church Yard, London.]—4to, 211 pages, plates.

1790—Churchman, John.—

[An explanation of the Magnetic Atlas or variation Chart hereunto annexed, projected on a Plan entirely new, by which the Magnetic Variation on any part of the globe may be precisely determined, for any time, past, present, or future; and the variation and latitude being accurately known, the longitude is of consequence truly determined. By John Churchman, late Land Surveyor for the district of the counties of Delaware and Chester, and for part of Lancaster and Berks, Pennsylvania. Philadelphia: Printed by James Johnson, in the North side of Market Street, between Third and Fourth Street, MDCCXC.]—Pam., small 8vo., with tables of variation of the compass, &c.

1790—?

[A summary view of the general principles of Electricity.] —Title page missing, 8vo., 76 pages, plates.

1792.—Lyon, Rev. John.—

[Remarks on the leading proofs offered in favour of the Franklinian system of Electricity, with Experiments to show the direction of the Electric Effluvia visibly passing from what has been termed negatively electrified bodies. By the Rev. John Lyon, Dover, Kent. London: Printed by J. Phillips, George Yard, Lombard Street, and sold by J. Dodsley, Pall Mall, and J. Phillips, MDCCXCI.]—Pamphlet, plate.

1792—Birch, John.—

[A Letter to Mr. George Adams on the Subject of Medical Electricity, from John Birch, Surgeon, London: Printed in the year MDCCXCII.]—Pamphlet.

MR. J. W. BRETT ON DEEP SEA SOUNDINGS.

The following is taken from Mr. Brett's paper "On the Submarine Telegraph," read in March, 1857, before the Royal Institution:—

"The great depths of the Atlantic have, until within these very few years, remained unknown. It has been stated that Sir John Ross sounded in the Pacific with a line of 10,000 fathoms, or about 11 miles, without touching bottom. Scientific men had come to the conclusion that the greatest depths of the ocean did not exceed 8 or 9 miles, and the uncertainty as respects all former attempts at deep sea soundings appears to have been very great, and in some cases appears to have been fathomless, eleven miles of wire having been cast out without touching bottom. At last it was proved that by a common twine thread for a sounding line, and a cannon ball of 60 lb. weight for a sinker attached, the line being allowed to run from the reel as fast as the ball would take it (care being had to pay it out from a boat which could be kept stationary, to maintain the line as perpendicular as possible), correct soundings could be obtained.

"The essential point was to time each hundred fathom as it ran out; and, by always using a line of the same size, and a sinker of the same weight and shape, a law of descent was established by the time of the descent; as it was found that 2 minutes and 21 seconds became the average descent from 400 to 500 fathoms, and

3 minutes	26 seconds	1000 to 1100	fathoms
4	„	29	„	1800	„ 1900	„

By this decreased rate of descent it could be ascertained the moment the line touched the bottom, for when this took place the currents would sweep the line out at a uniform rate, whereas the cannon ball, while it continued to descend, would drag it out at a decreasing rate.

"A contrivance was also made by which the line could detach itself, quills being inserted in the ends which passed through the hollow of the ball. Specimens of the bottom were thus brought up by the quills, on the ball striking the bottom, which proved to consist of the most minute microscopic shells.

"The greatest depths which have been reached by these means in the North Atlantic Ocean have been 25,000 feet."

THE ELECTRIC TELEGRAPH, AS AN AUXILIARY TO THE POLICE AND THE FIRE BRIGADE.

The following letter was published by Mr. Sydney Waterlow and Mr. Owen Rowland, in many of the daily papers, in April, 1857:—

Sir,—I beg to lay before you the description of a plan for effecting telegraphic communication between the police and fire-brigade stations of the metropolis. As these matters are at present under the authority of three distinct bodies, it would be necessary to have a distinct telegraph for each body, perfect in itself, but capable of instantaneously uniting with the other two, so as to form one system, in case of necessity, from fire or public commotion.

It has long been a matter of surprise and regret, that while the electric telegraph extends itself over the length and breadth of the land, connecting the nearest and the remotest towns of the United Kingdom with the metropolis, its advantages have not hitherto been secured as a means of transmitting instantaneous intelligence between the numerous police and fire establishments which have under their care the protection of life and property.

The immense destruction of property, and the melancholy sacrifice of human life by fire, the poverty and distress consequent thereon, are subjects deserving the most serious consideration. The existence of such a ready and instantaneous means of procuring assistance, in times of danger, as the electric telegraph affords, would impart, as it were, a new feeling of security to the inhabitants of our large and densely populated towns.

The City of London, built, as it is, upon an undulating ground, is peculiarly favourable to the development of a system of Over-house Telegraphs. The plan has been successfully adopted in New York, Paris, Brussels, and many other large continental towns. In America, wires have been carried upwards of a mile, without any intermediate support, and have now been in operation several years.

In advocating a plan of Over-house Telegraphs, I have no desire to depreciate the merits of the under-ground system, except on the score of expense, the difference in which respect is enormous, and the City would entail upon itself a perpetual source of annoyance to the public by its adoption. When the under-ground wires are injured, or become impaired, it is difficult to find the exact locality where the mischief arises; but if any accident should befall the suspended wires, the injury could be immediately discovered, and as speedily repaired. To replace an impaired wire would be only the work of an hour, while, if it were under-ground, its repair would be a work of days, besides the annoyance of shopkeepers, and the interruption of traffic occasioned by opening the streets.

As to the *modus operandi*. It being understood that on the appearance of the "fire" signal at either of the junctions, the systems are to be immediately united, the same signal would instantaneously appear upon the telegraph dials at every police and fire-brigade station in the metropolis. The exact locality of the fire, its extent, the number of engines and police required, would be immediately transmitted to all, or to particular stations, according to circumstances. Should the fire be extinguished, notice could be sent, and the engines stopped, or they might be intercepted by the police, or by information to be obtained at any fire or police station on the way. False alarms could not, as at present, harrass the brigade, or impose

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unnecessary trouble and expense in dragging out engines and fire escapes when not wanted.

When a fire breaks out now, the police, or any person who may happen at the time to be present, hastens to the nearest fire station, which may be a long distance from the scene of the conflagration, and then from that station messengers are again sent to all the others. Sometimes, at night, the reflection gives the alarm, and is the only guide, though too often a deceptive one, the firemen have to direct them to the spot where their services are required. All these proceedings occupy much time; and often, before the engines have arrived, the premises are entirely destroyed; in other cases, the fire has been subdued, and in others the alarm is found to be false. Nevertheless, engine after engine continue to arrive, to no purpose, when (and such has been often the case) other fires are raging in the very neighbourhood from which they have been unnecessarily withdrawn. The telegraph, as already observed, would be the means of concentrating at any required spot the whole power of the brigade; and the authorities at the chief Fire Station in Watling Street, or the chief police station in Old Jewry, or Scotland Yard, would be enabled to regulate the movements of their men as accurately as if they were under their own eyes—a system which could not fail to result in the saving of much trouble, expense, and an immense amount of property and human life. Ithas been very truly observed, there can be no doubt that in many a half-hour, occupied by messengers, &c., a larger amount of property has been destroyed than would have paid for constructing a most efficient and complete telegraphic system, embracing the whole of the metropolis. Of the truth of this the fire at Camden Town affords a ready illustration.

Although, to an observer, the working of the telegraph may appear complex and difficult, it is in reality but a question of practice, as the young men upon the railways are very soon trained to transmit messages in an expeditious and accurate manner, in addition to their other duties.

Having thus endeavoured to point out the manner in which the electric telegraph may be beneficially and advantageously applied to the purposes above described, I sincerely trust that, however inadequate this attempt may be, the public will give the subject that fair consideration which its importance demands; feeling sure, that if the scheme is well considered, the day is not far distant when it must be carried out.

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November 19, 1862.

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TELEGRAPH SHARES.—*Thursday's Quotations.*

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Stock	British and Irish Magnetic, A.	100	54 to 57	———
20	Do. B 7 per cent. till 1862 .	—	———	———
Stock	Electric Telegraph . .	100	100 to 103	———
25	Do. New . . .	20	———	———
5	London District Telegraph .	4¾	4 to 3 dis.	———
—	Lond. & S. Ireld. Direct Tel.	all	———	———
10	Mediterranean Extension Tel.	all	3 to 4	3¼
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ½	———
1	Do. registered . . .	all	⅜ to ½	———
10	Do. „ . . .	all	4 to 6	———
2	Telegraph to India . .	1	¾ to ½ dis.	———
5	United Kingdom Telegraph .	3	½ dis. to par.	3

ON THE NOMENCLATURE OF SALINE COMPOUNDS, AND THEIR THEORETICAL CONSTITUTION.

By James Martin.

The opinion was once entertained by chemists that when an oxide was acted upon by a hydrogen acid, that neither the oxide nor the acid were decomposed, but that direct combination took place; hence arose the names of hydrochlorates, hydrosulphates, and hydriodates.

But a more searching examination has demonstrated that both the oxide and the acid are decomposed, the oxygen of the oxide going to the hydrogen of the acid to form water and the chlorine, iodine, bromine, or whatever salt radical it may be combining directly with the metal. One or two facts may be cited in support of this theory.

Most of the oxides when heated with a hydrogen acid, and the solution evaporated sufficiently to crystallise, yield salts which contain neither oxygen or hydrogen, but the metal only combined with the salt radical. It is also found that when many of the metals are heated in pure chlorine gas, rapid combustion ensues, and salts are obtained identical in composition and properties with those yielded when the oxides of the same metals are treated with a hydrogen acid.

It is true that many of these salts, when crystallised, contain oxygen and hydrogen in the exact proportions to form an oxide and a hydrogen acid, as examples of which the salts of barium, strontium, calcium, copper, and manganese, may be mentioned: but, as the application of the most gentle heat is sufficient to expel them as water, it is quite fair to assume that they exist as such in the salt.

The oxysalts at present are regarded as combinations of oxides with oxyacids, although there is a theory which renders them harmonious with those already mentioned; but, before entering into this theory, it will be necessary to say a few words respecting the acids which enter into the composition of this class of salts.

The greater number of those bodies which have been termed oxyacids have never been isolated, and we are supposed only to know them in combination with water or a base; thus what is termed nitric acid $N O_5$ cannot exist alone, but when in combination with water it constitutes one of the most energetic acids known. Oxalic acid, again, cannot exist in the anhydrous state; for, immediately on abstracting the water from it, it is resolved into carbonic acid ($C O_2$) and carbonic oxide ($C O$) gases.

Again, with regard to such compounds as have been described as *anhydrous* sulphuric acid and *anhydrous* phosphoric acid, their affinities for bases are very different to those of their aqueoacids. In the absence of all moisture, the anhydrous sulphuric acid has no action on litmus-paper; and these anhydrous compounds certainly do not manifest acid properties at all comparable to that of their combinations with water.

Proceeding upon these facts, Sir Humphrey Davy clearly pointed out that we have no certainty that the hydrated sulphuric acid really contains water, or the sulphate of soda, oxide of sodium; and that, instead of the formula $H O S O_3$, we might, with better reason, adopt the formula $H, S O_4$ for the acid, which would thus be considered a hydrogen acid, differing from hydrochloric acid only in containing a compound radical ($S O_4$) instead of a simple one (Cl). But, in the first place, chlorine may not be really a simple body; and, secondly, if it were so, we know that compound radicals exist, performing exactly the part which is here ascribed to the hypothetical body, $S O_4$.

Cyanogen is an instance of this. It is a compound ($C_2 N$) which forms with hydrogen hydrocyanic acid, H Cy, which acts on bases exactly as hydrochloric acid does, forming a neutral salt (a cyanide) and water.

Now, let us assume in all these cases, as well as with the hydrogen acids, that it is the hydrogen which is the acidifying element, and observe how close a parallel may be drawn between the action of hydrochloric acid and that of sulphuric acid on the metal zinc and its oxide. When hydrochloric acid acts on zinc the metal is dissolved, chloride of zinc is formed, and hydrogen liberated. When the same acid is brought into contact with oxide of zinc the same salt is formed and water produced. In the case of sulphuric acid and zinc, instead of supposing that the *water* yields its oxygen to the zinc and sets hydrogen free, let us suppose that it is the hydrogen of the acid which is *replaced* by a metal, and being set at liberty is given off in the gaseous form, and see how exactly each corresponds. Again: when sulphuric acid is made to act on oxide of zinc, we may regard the action the same as takes place when hydrochloric acid is made to act on it—the hydrogen of the acid taking the oxygen of the base and forming water, and the S O combining directly with the metal.

The combination SO may be regarded as a radical capable of being substituted for the elementary substances, chlorine, iodine, bromine, &c. It is true that these oxygen radicals have not been isolated; but this difficulty is no greater than we are driven to in the opposite hypothesis of the dry acids. It is evident that the same view is applicable to the hydrated oxygen acids in general, which may be made hydrogen acids, by assuming the existence of a new radical for each containing an atom more oxygen than the oxygen acid itself, and capable of combining directly with hydrogen and the metals.

But there are certain anhydrous bisulphates and bichromates—such

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as bisulphate and bichromate of potash—which, in a measure, tend to disprove this theory, and until these are more satisfactorily accounted for, it would be unwise to adopt it.

Moreover, some new nomenclature would have to be adopted for this class of salts, which would be attended at first with great inconvenience; but it certainly has the advantage over the old theory in this—that, instead of two, it makes but one great class of salts; and it accounts for the remarkable fact, that, *in neutral salts, as many* equivalents of acid are required as there are of oxygen in the base—a fact which is not explained by the old theory, whereas it becomes a necessary sequence in the new, since it is obvious that, to form water with the oxygen of the base, an equal number of equivalents of hydrogen must be derived from the acid.

In this simple way the adsurdity of having two different explanations for the same phenomenon is avoided, and the following general definitions of an acid and a salt arrived at:—

An Acid *is the hydrogen compound of a simple or compound radical, possessing the power of neutralising bases; and its general formula is HR.*

A salt *is the compound formed by replacing the hydrogen of an acid by a metal; and the general formula for a salt is MR.—British Journal of Photography.*

THE HISTORY OF THE DOVER AND CALAIS TELEGRAPH (WRITTEN BY ITSELF).

But now let me advert to my condition after having received the "earnest attention" of my *soi-disant* projectors to fit me for my destination between Calais and Dover. It might have been expected, that under the united sapiency of these gentlemen I should have been brought forward as a perfect prodigy—an extraordinary production, at which the world might gaze with wonder, or at least as a complete specimen of what a submarine telegraph should be. In the expectation, however, of either of these results I was doomed to worse than disappointment. Instead of having even the semblance of a respectable submarine telegraph, I was a miserable abortion—a nondescript! Science laughed at me, and I do the same now, although at that period I was too much grieved at the ridiculous exhibition made of me; but time and repeated mishaps have somewhat blunted my feelings, and inured me to my hard fate, and I can now laugh at that which was then a source of sorrow and vexation to me. I do not give the description of myself of how I was fashioned to make me the means of permanent telegraphic communication between two of the greatest nations in the universe, whose political, commercial, and social intercourse render such a medium absolutely necessary. Mr. John Brett himself says—"The first attempt to connect England and France by a submarine telegraph was made in 1850, with a copper wire enclosed in gutta percha, a material which opportunely came to our aid about that time."

Behold me, then, a small fragile wire, insulated with gutta percha, a non-elastic substance, without any other covering to protect or strengthen me, or to give me the requsite specific gravity: and judge, reader, for yourself, how far I was possessed of the essentials to constitute me a submarine telegraph.

Parturiunt montes—no. I will not continue the quotation, it is not an apt one; for, although the mountain in labour brought forth only the little mouse, yet still, though minute, it is a beautiful and perfect specimen of one of nature's productions, while I, the offspring of the Brett's mountain, was a nondescript, neither "fish, flesh, fowl, nor good red herring"—a thing of no utility or perfection.

But where was the development of the "constant attention," and the united researches of these gentlemen, when they admit in 1850 that they were obliged to have recourse to a material which opportunely came to their aid about that period. Said I not correctly, that, although they registered a scheme in 1845, they were totally unprepared, at that time, with any plan to carry out the project which, of all others, requires the most particular organization, the greatest skill, and a thorough, perfect, and intimate knowledge of all that appertains to me? That they were not so prepared is fully shown in the admission, that when they were compelled to carry out their agreement to lay me down across the channel, or forfeit their concession, they were necessitated to adopt a material hitherto unknown, but which "opportunely came to their aid about that time."

But to proceed. Mr. John Brett, in continuation, says:—"The end of the wire attached to land was carried into a horse-box at the South Eastern Railway Terminus, and we commenced paying out the wire, pieces of lead being fastened to it at intervals, to facilitate the sinking." Major Dalgetty could not be more astonished at the bows and arrows of the "Children of the Mist" than I was at this primitive mode of giving me the necessary ponderosity to submerge me. The provident old major, however, ultimately found that these bows and arrows of the untutored sons of the mountains could be turned to good account; but I was fully aware that in the absence of other causes, the pieces of lead attached to me must alone inevitably prove my destruction. If I were not possessed of adequate continuous specific gravity in my entirety to sink me, the application of weights at intervening distances would have the effect of sinking and anchoring me at the particular points to which the lead might be attached, while the buoyancy of the other portions, not so weighted, would create considerable oscillation and friction, by which, eventually, they would be separated from their primitive anchors.

He then proceeds to say, "Electric communication from the vessel to the shore being kept up hourly. During its progress, the only drawback was a fear lest this frail, experimental thread should snap, and involve the undertaking in ridicule." Was it not involved in ridicule? Was it because "this frail, experimental thread" did not snap during its progress, that the absurdity and folly of employing such a means to carry out so important an undertaking ceased to be longer apparent? No; the whole affair became ridiculous from the fact that the emanation of Messrs. Brett's united ingenuity and "constant attention" was nothing better than what he admits to be a "frail, experimental thread," and that in using this, no other result could have been expected than the one he himself describes:—"In attempting to resume communication early next morning, no response could be obtained, and it soon became evident that the insulation was destroyed, either by a leakage of the electric current, or by its having snapped asunder!"

And yet, notwithstanding the account he has given of the undertaking, he says:—"The trial was, however, successful." Indeed! I confess I cannot arrive at the same conclusion; but that may be from the obtuseness of my intellect, which cannot reconcile the assertion of success with the fact of failure. At least, it is somewhat paradoxical, and may puzzle far more intelligent minds than mine. No wonder that Mr. Brett and his colleagues in the Atlantic affair have announced that also as being a successful trial. They can do so with equal reason. In the latter case, however, I am left at the bottom of the Atlantic in my entirety—"alone in my glory;" while the shareholders, like Lord Ullin, are "left lamenting." Here, again, I cannot be said to be lost, for everybody knows where I am, being, like the Irishman's kettle, at the bottom of the sea; and when Paddy recovers his culinary treasure, and is able to use it for boiling the water to brew his tumbler of Kinahan, or, having taken the pledge, to infuse his Bohea, Souchong, Hyson buds, or other descriptions of the oriental herb, to produce "the cup that cheers, but not inebriates," then may I as reasonably expect to be recovered, and made to transmit the mysterious fluid which science has rendered subservient to the use of man, and the medium of inter-communication between nations separated from each other by expansive oceans.

But with regard to my position across the English Channel I never had even this remote chance of ultimate recovery. From the first day of my submersion I was, in the true and literal acceptation of the term, totally lost. No one knew where I was, or what had become of me; my buoyant limbs were severed and scattered and parted for ever, drifted in various directions in ocean's vast expanse. All that remained of me were the portions only attached to the pieces of lead already adverted to. Oh! how I wished that they, too, could have been released from the thraldom, and carried away with their buoyant brethren! But it was not to be; and here, like a martyr, tied to the stake, I was compelled to undergo, in my ludicrous and pitiable state, all sorts of indignities. In this position, even the very fishes laughed and jeered at me, and some of them, more learned than the rest, would, when they passed and repassed me, satirically remark—"*Si monumentum quæris circumspice.*" These, I suspect, were some knowing fellows, of the piscatorial tribe, who once were denizens of the Thames, where, having disported in happier and purer times in the neighbourhood of St. Paul's, became cognisant of the inscription with reference to its constructor, and who had, like sensible fishes, emigrated to their present locality, preferring the limpid and wholesome briny to the muddy and pestilential water, miscalled fresh.

In addition to the statement that "the trial was, however, successful," Mr. Brett further adds, "And the *Times* of the day justly remarked—'The jest of yesterday has become the fact of to-day.'" Only a few hours after, however, on the following morning, the *Times* could again, with more aptititude, have repeated the self-same words, with a slight transposition, and said—"The *fact* of yesterday has become the *jest* of to-day."

In bringing this painful portion of my story to a conclusion, I have

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only to add, that if this had been a mere experimental trial, it would have been a most ridiculous and absurd one; but when it was a serious attempt to establish me as a permanent medium of communication between the English and French coasts, in accordance with the conditions of the concession, which stipulated that the cable should be laid down in efficient working order in 1850 (a year longer than the time originally specified, which was 1849), or, failing in this, that the concession should be altogether annulled, I cannot refrain from expressing my indignation at the ludicrous exhibition made of me, and which was nearly proving fatal to my prestige for ever. All Mr. Brett's exertions went only to show, that instead of my being a sound, healthy, and perfect specimen of a submarine telegraph, I was not altogether still-born, yet, at the best, only a poor puling infant, with just sufficient vitality to squeak out, "All well," and "Good night;" and then departing at once to that well-known individual so familiar to all sailors, 'ycleped Davy Jones. I must have been the infant Thomas Hood had in his "mind's eye" when he wrote the following epitaph :—

"Since I was so soon to be done for,
I wonder what I was begun for."

Of course, I can have no recollection, in my pitiable and expiring state, of having given utterance to the words imputed to me—"All well," and "Good night," and alleged to have been recorded in Roman type! I should rather have supposed they might possibly have struck upon Mr. Brett's tympanum in hearing others, or himself, cantating the old well-known duet of "All's well" in the course of the evening's festivity and jollity, consequent on his imaginary success; but after the attestation of this fact, so carefully collected by his trustworthy emissary, and forwarded to the Emperor, signed by some ten persons, it is very evident that this could not have been the case. It must not, however, be for one moment supposed that the Emperor, with his astute intellect was in the least deceived in the matter. It was not in consequence of the document, to which he could not attach any value, as it was the record of failure and not of success, but solely to His Majesty's own kindness and consideration, that the penalty was not exacted in the forfeiture of the concession, and that "a year of grace for another trial was granted."—*"The story of my life," By C. West.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—Your correspondent, Mr. Rowland's, experiments on the conductivity of smoke and steam are interesting; but are, I fear, like the earth currents, described, some time ago, in your journal, resolvable. The two miles of aërial insulated copper wire, alluded to by your correspondent, were tested by several others beside himself, your humble servant among the number, and only found free from leakage when the atmosphere was *very dry*. The cause of this will be obvious to all your readers, when they learn that each mile of wire was supported by no less than 48 insulators, 32 of which were large porcelain inverts, and the remainder terminals, made of the same ware. Each of the former presented from 35 to 40 square inches of conducting surface, and the latter but imperfectly protected from rain and watery vapour, at the points to which the wire was suspended, by large open caps. The wires were led into the testing room through two of Walker's porcelain cones (corrugated on the outer surface) secured in the wooden roof. I think you will agree with me that these were not the sort of insulators for delicate experiments in the open air, with the tension of 512 elements; and that, in reconstructing the Government apparatus, the most necessary and important part of the work, good insulation, was either overlooked or misunderstood. *This was not the case with the wires prepared for Mr. L. Clark's experiments, described in your journal of 31st ultimo.* The condensation of steam on the insulators, I have so briefly described, would produce leakage, and if loss of insulation, contact as well, since the poles supporting both wires were braced together by the wood work of a stage or platform that ran along but a few inches below the lowest of the wires. If the experiments were repeated, substituting, for the large porcelain terminals and inverts, the double earthenware insulators, with ebonite-covered pins, recently invented by Mr. C. F. Varley, and now extensively used by the Electric and International Telegraph Company, I will venture to say that your correspondent would find both smoke and steam to offer a most contumacious resistance to a current, notwithstanding its being the tension of 512 well insulated elements.
—I am, sir, yours respectfully, Quisque.
London, N.W.

To the Editor of The Electrician.

Sir,—I have had interviews recently with a number of gentlemen deeply interested in the progress of telegraphy, both by sea and land, with the view of establishing an "Institute of Electricians;" my proposal has been, in every instance, received with kindness, and with a promise of co-operation on the part of the gentlemen whom I have consulted. I have, therefore, determined, with the assistance of those gentlemen, to organize all those who love the science declare their view to your obedient servant, Telegraphic Soirée, to be held in London, in the month of January, 1863.
Owen Rowland.

To the Editor of The Electrician.

Sir,—A few days since, I purchased a bar of steel, having it bent into a semi-circular shape for a magnet: I have tried to magnetize it by the ordinary method with artificial magnets, also by an electro one, and with the voltaic battery as described in "Noad's Electricity, but neither of these means have any effect on it. If you would tell me how this bar is to be magnetized, I shall be very much obliged to you. Hoping I am not troubling you too much, I remain, Sir, your obedient servant, T. H. K.

[See Vol. 2, p. 47, We advise you to try the following method:—A long strip of copper is formed into a flat coil with a centre aperture of sufficient size to allow the steel bar to pass freely through. The strip, about ¼ inch in breadth, may be cut from a sheet of thin sheet copper, it should be varnished or otherwise guarded from contact, and made up into a coil of 15 or 20 turns. The extremities of the coil must be so arranged as to be readily connected with the poles of a battery of great qaantity, care being taken that the metallic circuit may in no part offer resistance due to insufficient contact, &c. The "cast-iron" battery, or that of Grove or of Bunsen, may be used, several cells being united for quantity, or by their similar poles. To magnetize the horse-shoe, place it, before the voltaic circuit is completed, within the coil, so that the latter may surround the middle portion, place a soft iron armature upon the poles, complete the circuit, and move the coil steadily to one of the extremities of the bar, then to the other extremity, until ten or twelve passes have been made. If unsuccessful, look to the insulation of the coil, and increase the battery power, which should be sufficient to give a bright spark by breaking contact in mercury.—Ed. E.]

To the Editor of The Electrician.

Sir,—Will you, or any of your talented correspondents kindly favour me by answering the following useful questions in telegraphy.

1. Required, a rule whereby the diameter, in decimals of an inch, of copper wire can be ascertained?
2. One mile of No. 16 gauge copper wire having a diameter =·0625 of an inch, is here supposed to be a standard unit of resistance to a voltaic current: how many such units would there be in one mile of copper wire having a diameter = ·0042 of an inch?
3. How many standard units of resistance would there be in one mile of iron wire having a diameter = ·0058 of an inch; the specific resistance of copper and iron being in the proportion as 1 : 6·45.
4. Professor Wheatstone's standard of resistance is one foot of copper ·071 of an inch diameter: How many such units would there be in (the usual standard of resistance) one mile No. 16 gauge copper wire having a diameter = ·0625 of an inch? Again, how many of "Siemens'" units are equal to the standard unit of resistance as given above?

The undersigned would also esteem it a favour if an example of each of the above could be given by way of illustration. Inquirer.

To the Editor of The Electrician.

Sir.—In the spring of the present year, telegraph cable manufacturers, I believe, were, solicited to send in to the Indian board, sample lengths of core for testing purposes, preliminary to an order being given for the one approved of and selected. This was done, and the order, merely a short cable of twenty miles, for some narrow part of the Persian Gulf, was given, and executed, doubtless to the satisfaction of the then engineer to the Indian council; at any rate, it was generally understood at the time that, satisfactory as the sample length proved to be, the twenty mile of core when completed far exceeded the most sanguine expectation of those who had long been convinced of the adaptability of caoutchouc insulation to warm climates, and indeed every one felt satisfied that the cable was up to the mark, when it had passed the ordeal prescribed, and more especially when it was known that the not too rigorous exactions of Sir W. Brooke were more than fulfilled, and having reached this point it was felt that the thing was so far settled, and that this short cable, which was generally supposed to be an experimental one, and the fore-runner of a much longer one (some thousand miles or so) was so far satisfactory as to be considered a base for future operations in this direction, that is to say, surpass it if you can, but never fall below the point of excellence therein attained, and if this is done, a success in long and deep sea telegraphy will have been achieved, that shall throw all previous successes into the shade, and thus demonstrate, beyond the possibility of a doubt, the feasibility of submarine telegraphy. It was but natural, therefore, that cable manufacturers should expect, when the time came round for submitting to competition the thousand mile cable for the Persian Gulf, that they would simply be required to send in tenders for the manufacture of the

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same, in conformity with a specification founded, in so far as its electrical requirements were concerned, upon the standard attainments of the twenty miles already manufactured, making it a *sine qua non* that that should be held the minimum of its insulating and electrical perfectibility.

But another course, it appears, has been taken, which can scarcely be considered just to the manufacturers, since it puts them to expense and trouble, which can hardly be deemed necessary. They have again been required to prepare and send in, specimen lengths (some 200 or 300 yards, I presume), for the purpose of being tested. Now this course not only entails unnecessary trouble and expense upon the parties above referred, but it is a tacit ignoring of all that has previously been done, and done too, so well; and wherefore? Far be it from me to advocate a wanton disregard of the prime object to be attained, especially by any department of Government, and in the matter of telegraphy, too much care cannot be exercised, it being of the greatest importance, that in an undertaking which must necessarily entail expense, to be counted by hundreds of thousands of pounds, that a cable only of the first class should be selected, seeing that a very small defect may render all the expense and trouble absolutely abortive, But it is possible to go to the opposite extreme, not that they can do wrong by taking such a course in this instance, assuming the ruling notion to be a good cable. I have said it is unnecessary, also that it ignores previous attainments, and this latter contains a consideration of no mean importance, since it sets at nought the labours of an eminent and indefatigable public servant. I do not say that this was intentionally done, or that any such motive actuated any individual member of the Council, when this course was resolved upon, but it is liable to have that construction put upon it nevertheless.

The management of telegraphic development in India, has fallen into new hands, and it may be considered necessary to have a new beginning based on promises entirely new, and of their own formation, and if the world is to be benefitted by such a course, and the work of telegraphic intercommunication between India and Great Britain hastened thereby, we shall have no just cause to complain, but would rather commend a careful prudence, which evinces a desire to place the enterprise beyond the possibility of failure. But this, in the opinion of all practical and unprejudiced telegraphists has already been done, and so we must perforce, come back back to our old point, and insist that there was no necessity whatever for putting the cable makers to fresh trouble and expense to prepare new samples. Besides, it was holding out hopes to gutta percha cable manufacturers which (if Indian telegraphic development is remained true), could never be fulfilled; past experience having demonstrated beyond all doubt, the utter unfitness of this material for tropical climes. The proceeding, therefore, is upon every consideration, indefensible, unnecessary, and impolitic. M.

MR. WEBB'S NEW WORK ON ELECTRICITY.

To the Editor of THE ELECTRICIAN.

SIR,—The first part of Mr. Webb's "Treatise on the Laws of Induction and Conduction," has just appeared, and it is to be hoped some one will favour us with an independent critical review of its extended geometry and mathematics. I, for one, feel totally incompetent; but, with a firm conviction that these problems are not in the main, and especially in their practical bearings, very dependent on such scholastic methods, I would pay homage to the practical and popular interest felt in these questions, by some brief notice of the positions taken by the author.

If I understand the prolix statements up to page 11, the author objects to the view of induction, as enunciated by Faraday and others, that an action is *primarily* set up across the particles of the insulating medium, by which an opposite charge is accumulated on the outer surface of any dielectric in connection with earth; and Mr. Webb prefers to regard the same result as being produced *primarily* by an earth conduction from the opposite pole of excitation to that which charges the interior.

But, methinks, the writer would not have taken so much pains to quote high authorities, and then devote a treatise on geometry and mathematics to their discomfiture, if he had not been somewhat biologized in favour of his own hair-splitting distinctions.

For my part, I do not see that the recognized "explanations clash with (the unrecognized) views and axioms ordinarily given," and, without any great strain of electricism, we might add Mr. Webb to the galaxy of authorities, and say, they all shine with tolerably equal brilliancy in the general enlightenment of the subject.

If we apply the zinc of 20 cells to a submarine cable of 500 miles in length, and call the surface of conduction A, and the outer surface of dielectric B, then, whether the A acts inductively on B, by a primary action, or whether the identical copper current travels 500 miles to reciprocate the influence, so that we might as truly say that B acts upon A, &c. Still, both views must agree in this, as settled by all, *that the amount of action is determined by the shape, thickness, and specific inductivity of the insulating material.*

But, while we all agree as to the main facts and laws, still there are differences of aspect in respect to minor points, and the language of expression is not perfectly identical in all. What, then, may we say of the author's special idiosyncrasy? Why, even this, that he has made a hobby of the subject, and rides the high horse to a somewhat Quixotic result; for, wherein he is mostly special, and delights to magnify his originality, he is, probably, most inaccurate.

There is this difference between Faraday and Mr. Webb, that, whereas, the former has correctly enunciated the principle, he has never sought to impugn the Webb aspect, which is true in many cases, and is never contradictory to that of Faraday; but Mr. Webb unduly exalts his aspect, and impugns the great principle which is ever paramount.

Again, referring to our cable of 500 miles. Suppose 200 miles of its length were laid in a separate part of the earth insulated from the rest, or laid upon another globe like the earth, but insulated from the charging source. In this case, we presume, and orthodoxy provides, that induction would take place just as freely as if the whole outer dielectric were in connection with the other pole of the battery, and if Mr. Webb be not astride his hobby, he would surely admit the same.

In like manner, I have no sympathy with multiplying diagrams, *ad infinitum*, and compiling a large treatise of hair-splitting distinctions, in a region of complex tension effects, where guessing may be sometimes in favour of one party, and sometimes of another, still leaving the great principles totally unaffected. Take, for instance, diagrams 8 to 11, pages 18—23. Here the Webb aspect is made to triumph over the views of Professor Daniell, but the probability is, that the Professor was quite right, and that Mr. Webb is wrong.

Mr. Webb promises to deal with some of the practical problems of the day, and, seeing that he has had some experience in submarine telegraphy, the homeopathic quantity dispersed in 156 pages is something quite astonishing; but if he ever does leave the cloudy region of insulated rooms, and electrified shells, I hope he will find practical men and earnest students to welcome his return with honest acclamation and candid criticism. S. E. P.

November 4th, 1862.

[The following is the translation of a communication from the Spanish Telegraph Authorities.]

Copy of a letter of the Chief of the Direction of Telegraphs, insomuch as it refers to the request of Mr. Desmond G. Fitz-Gerald.

The telegraphic apparatuses that are employed in Spain are in accordance with international treaties; those of Morse improved by Digney, with some other auxiliaries (auxiliary instruments), of the invention of the Spanish administration of telegraphs.

There is no doubt that Hughes's apparatus possesses the good qualities of which you have been told, but it cannot vie with that of Morenes, Subdirector of the Telegraphic Corps of Spain, which is only known to the General Direction here, who are experimenting with it, with the most favourable results. Within a few days I shall be able to give you all the details, which I abstain from doing now, from motives of prudence; but I can at once announce to you

1. That the receiver has a printing apparatus that produces two equal copies at the same time, which, being cut by the blank space that separates them, serve, the one to be delivered to whom it is addressed, and the other to remain in the office for reference.
2. Its velocity is greater than that of Morse.
3. Its manipulation is so easy, that with only two hours' practice it is learned to be used with rapidity.
4. Its exquisite sensibility renders unnecessary a local battery.
5. The mechanism is very simple, the transmission being obtained *double*, and clearly reproduced, as with that of Hughes', but without the complication of the latter.
6. Without need of isochronism, it has a proof mechanism, whose aid permits the regulation of the movement of the apparatus without resort to preliminary experiments and trials.
7. The simplicity of the mechanism, the exact number of pieces that produce the movement of the apparatus, and speed of transmission, make it invaluable, especially for stations situated in places that lack watchmakers or mechanical artizans capable of repairing the damages by wear and tear, or breakage of the instrument.
7. (8). Although somewhat similar to that of Dujardin de Lille, it is more practical and more perfect in this sense, for the inestimable advantage that is so evident in it, is the diminution of the staff for writing and copying the despatches that come out of the apparatus, as the said despatches are double copies on one sheet of paper.

To the Editor of THE ELECTRICIAN.

SIR,—In the present state of submarine telegraphy, it is above all necessary that no experience once gained should ever again be ignored or forgotten; that former failures should be traced to their true sources, and that, when one head of the hydra "Humbug" has been cut off, the searing brand should be effectually applied by the press to prevent any resuscitation.

Will you, therefore, give your readers a succinct *resumé* of the failures which caused the originally *extremely* light cables to be abandoned in favour of heavy ones, for these seem by some parties to be now studiously kept in the background.

In this, as in many other things, the maxim *Medio tutissimus ibis* is the

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only safe one. On two occasions, where experiments were being made with cables of very light specific gravity, a surface current ran away with them to such an extent as to necessitate cutting, to prevent further loss of cable. An idea has recently been brought forward which also requires comment, that it is possible to communicate without any wires or cables. If this were what it professes to be, then, indeed, electricity has culminated in animal magnetism; and henceforth, both post office and telegraph companies may shut up their offices in despair, besides many other curious consequences, of such a transcendental state of things.

But first, it is no novelty whatever that *signals* or *messages* can be sent *for certain distances* across water or through earth (if such an expression be allowed), without wires. The earth return current (so called) is a familiar example. But to do this there must be more resistance on the circuit through the wire, or else a better insulation from the earth in one direction than in the other. On this subject, however, I solicit the expression, by some electrical authority, of the existing knowledge on the subject, showing how far we have gone, and what we can *not do* in this direction.

But even if we allow all that has been brought forward to be true, you will permit me to express a doubt whether *electricity* can be taught to *elect* persons at a distance as well as batteries; whether, in short, Dick might not receive the message from Tom which was intended for the private edification of Harry. When Jeff. Davis thus whispers to Slidell and Mason, will not President Lincoln's "ear flap." Will even the Emperor be able any longer to hide his intentions when each man possesses a battery in his pocket, more formidable, because less suspected, than either Armstrongs or Whitworths, and is able, by putting his wire to earth, to hear the secrets, and defeat the intentions, of his enemy.

London, November 18, 1862.

Telegraphic News.

DEPUTATIONS.—A deputation of gentlemen interested in telegraphic communication between Great Britain and America had an interview on Wednesday with Lord Palmerston. The deputation consisted of Sir. J. D. Hay, Bart., M.P., Rear Admiral G. Elliot, the Hon. W. Napier, W. Vivian, Esq., W. H. Smith, Esq., Captain Rowet, and Mr. Francis Edwards, Solicitor. The same gentlemen also had an interview with the President of the Board of Trade on Saturday.

THE United Kingdom Electric Telegraph Company (Limited) having completed their contract for the erection of their second trunk line, from London to the North, uniting Northampton, Leicester, Nottingham, Derby, Chesterfield, Sheffield, Barnsley, Wakefield, Huddersfield, Halifax, Leeds, Bradford, Selby, Hull, York, Congleton, the Hartlepools, Durham, Sunderland, Newcastle, Shields, &c., intimate that the only shares which they can now issue are those set apart for the above-named towns.

SUBMARINE TELEGRAPHIC EXTENSION.—An additional submarine telegraph cable was laid across the Straits of Messina on the 25th ult., under the superintendence of Mr. W. A Marshall, as acting engineer for the Italian Government. The number and force of the currents, together with the depth of the water, present obstacles of no small magnitude, and render the success of the operation justly a subject of congratulation.

Miscellanea.

LONGEMANN'S MAGNETS.—We learn from *Poggendorff's Annalen* the following particulars relative to the large magnets of this eminent maker at Haarlem:—1. One consisting of seven elementary magnets (Lamellen), weighing about 61 kilogrammes, with a carrying power of about 275 kilogrammes, at the Ecole Polytechnique, Paris. 2. One, consisting of five elementary magnets, weighing about 45 kilogrammes, with a carrying power of 208 kilogrammes, at the Royal Institution of Great Britain. 3. One consisting of five elementary magnets, weighing 43 kilogrammes, with a carrying power of 200 kilogrammes, in the possession of M. Elias at the Hague. 4. One, consisting of five elementary magnets, weighing about 30 kilogrammes, with a carrying power of 150 kilogrammes, at the Military Academy, Berlin. Several others, with a carrying power of 100 kilogrammes, are in the possession of Professor Ceansins, at Zurich, of M. Kilson in Haarlem, of Professor Tyndall, London, and others. Our readers will recollect that the kilogramme is equal to 2lb. 3oz. 4·17 drs. Since 1859, M. Longemann transferred his business to MM. Funckler ahd Richard, who now manufacture large magnets. In relation to this subject we may state, that, lately we saw a magnet, about an inch in length, weighing 36 grains, and capable of sustaining 140 times its own weight. This magnet made by Haecker, of Nuremberg, was exhibited at the Royal Institution in 1851.—*Illustrated London News.*

CONDUCTION RESISTANCE.—Jacobi, in November 1841, thus expressed the conditions on which the quantity of electricity traversing the circuit of a single couple, or the intensity of the circuit, is dependent:—"The power which sets the current into motion, depends on the natural electric condition of the effective metals of which the battery consists, and this power is always more considerable as the metals are more distant from one another in the tabulated series. But this power experiences certain obstructions, or as we frequently say, *conduction resistance* (leitungs miderstände), which weaken the strength of the current. If, now, we pursue an electric current along its channel, we shall find the *first* resistance that it experiences at the plane of contact, where it passes from the zinc to the liquid in the battery. A *second* resistance is experienced whilst passing through that liquid; a *third*, when the current leaves the liquid to enter the copper plate; and a *fourth* in the conducting wire. All these resistances being added together, and brought to a common unit, we have, by many experiments and observations, obtained the following principal law:—*The strength of current diminishes as the sum of the operating resistances increases.* So that when this sum is double, the strength of the current is reduced to one-half of the original standard; and when the resistances are but one-half of the first unit, the strength of the current is doubled, &c. The determination of these individual resistances, however, is very difficult, and all that has been acquired is, to obtain a general survey, to which we can have some practical reference."

THE MARINER'S COMPASS.—In several European idioms, as in the Greek, Italian, Romance, Bosnian, Croatian, &c., the name for the magnet is *calamita*, a word which appears to be of Greek origin, and is given by Pliny as the name of a small frog. The application of the term to the magnet is explained by a fancied resemblance to that animal in the magnetic needle, when poised in water, by means of small reeds, according to the usual mode in early times of adapting it to the mariner's use. But, that the idea of such a resemblance was not original in Europe, may be suspected from the fact, that the Bosnian name for the compass, *anghmyaoung*, signifies lizard, and that this mode of using the magnet was adopted in China about eighty years previous to the earliest mention of the needle by any European writer.

ELECTRICITY IN CASES OF POISONING BY LAUDANUM.—The following case was reported in the *Lancet*, in the year 1841:—A man was admitted into the Middlesex Hospital about six hours after having taken an ounce of laudanum (containing twenty-six grains of opium). At the time of admission he was, apparently, lifeless; the surface of the body was cold, countenance pale and livid, lips purple, pupils contracted to a mere point, respiration scarcely perceptible, pulse hardly to be felt. The laudanum was removed by the stomach pump, but, in spite of every exertion, the pulse became more infrequent, and was at times imperceptible, when recourse was had to electro-magnetism (? magneto-electricity), which was applied by means of a small battery with coil and contact-breaker. One wire was applied to the neck, and the other to the region of the heart, or epigastrium, and by these a succession of very powerful shocks was given. Its good effects were very apparent. The muscles of respiration were set in action, and the diaphragm contracted powerfully; the chest was more fully expanded, respiration was more perfectly carried on, and a corresponding improvement was visible in the countenance. The pulse improved and became more powerful, becoming steady when the current was interrupted for a few minutes. The application was continued for several hours, and was finally successful; thus clearly establishing the influence of electro-magnetism under circumstances hitherto considered quite hopeless.

To Correspondents.

ALIQUIS.—We regret to learn Dr. Hamel is no more. We are informed that at the period of his decease, he was engaged upon a paper in continuation of the articles which have appeared in this paper. Dr. Hamel was a firm friend of telegraphic progress.

J. MAC MURDO.—We will enquire, and inform you of the result. In our columns you will have "fair play."

R. PHILLIP.—Not in the least. Your contribution will be most acceptable. We go to press on Thursday.

P. L.—Muirhead's improved Daniell.

W. H. H.—Your contribution, acknowledged with thanks, was inserted previously to the receipt of your note of the 8th. inst.

R. MALCOLM.—Local news will be most acceptable. Telegraphists generally have not, hitherto, evinced much sympathy towards those engaged in the profession, who may require their assistance. In fact, it has been long observed, that the members of the telegraphic profession are an exception to the rule which generally governs the conduct of men engaged in a similar pursuit.

JOHN ELLIS.—We have received several letters referring to the system of carrying wires along the mail or common roads of the country, some for and some against this system. The United Kingdom Telegraph Company, as is well known, has constructed some hundreds of miles of lines along our old mail roads.

ENQUIRER.—See an article in the present number.

A CITIZEN.—Too late for this week.

*** The 2nd volume is now ready, and may be had of the publisher. Cases for binding have been prepared, and may be had at the Office, price 1s. 6d.

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The Electrician.

Vol. III. No. 56.—November 28, 1862.

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ON A METHOD OF SIGNALLING THROUGH SUBMARINE CONDUCTORS, BY MEANS OF CURRENTS OF INDUCED ELECTRICITY.

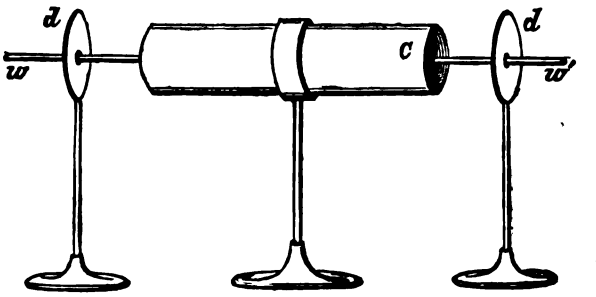
On one or two occasions we have directed attention to the theory involved in a method of constructing and working submarine cables, which, whatever may be its intrinsic merits, has the advantage of being easily resolvable into practice. The object in this system is to utilize, in the production of signals, the static induction which hitherto has been regarded as the principal difficulty to be overcome in the application of scientific principles to the problems of submarine telegraphy. The system in question, of which we have but suggested the outline,* gives a practical interest and importance to several of the principles of electrical science, which have as yet been considered mainly in the abstract. Its investigation, and its possible adaptation to the requirements of submarine telegraphy, were, therefore, problems which appeared to be peculiarly adapted for our columns; while the immense importance of the object in view seemed likely to lead to an interesting discussion upon this subject matter. But, although we are aware that the latter has been duly considered in various quarters, and has led to some important conclusions, it has, as far as we are enabled to judge, failed to attract generally the notice of those who are interested in telegraphic progress. We propose, therefore, to enter more familiarly into the consideration of various points involved in the application of the method of working cables by currents of statically induced electricity.

We may commence with a simple exposition of the conditions of working in aërial lines, and of the mode in which the inductive action interferes with the rapid succession of signals in the ordinary system of working in submarine lines.

Let a wire or rod of metal be supported and insulated by being passed through a central aperture in two discs of glass, or ebonite, fastened to uprights of wood or gutta percha. The wire thus represents an aërial conductor. The insulating supports being dry and warm, let us bring a charged electrometer—an instrument which measures electrical tensions—into contact with the wire. A portion of the electricity accumulated upon the electrometer will be communicated to the wire, as will be shown by the reduced indication upon the instrument; but the fact of the latter still remaining perceptibly charged (which will generally be the case), proves that the quantity of electricity transferred, and the "capacity for charge" of the wire under the given conditions, are comparatively small. The electrometer may be removed, again charged, and a second time brought into contact with the insulated wire. The indication of the instrument, after the first, second, or a greater number of contacts, gives the tension of the electricity accumulated upon this conductor. Now, it is to be borne in mind, that it is the difference of tensions between a conducting wire, as employed in telegraphy, or, practically, between the battery end of this conducting wire, and the earth, that determines the production of a current. *Ceteris paribus*, the current will be more intense as the difference of tension is greater; and *the retardation which will be experienced in the transmission of signals will be proportionate to the period of time in which a certain difference of tension, dependent upon the resistance of the circuit, can be established.*

Let us now (fig. 1) place the insulated wire in the axis of an *uninsulated* metallic cylinder, C, which, being in contact with earth, may represent the conducting bodies (earth or water) surrounding an insulated submarine conductor.

Fig. 1.



The insulation of the wire is in this case maintained by the stratum of air between the wire and the cylinder; but, instead of air, a solid non-conductor and dielectric, such as gutta percha or caoutchouc, may be made to surround the conductor.

Upon bringing the charged electrometer into contact with the wire at w', the instrument will be discharged; and it will be found that the number of contacts after charge necessary to obtain the same degree of tension in the charged conductor as in the former case, is, under these conditions, considerably increased, showing that the capacity for charge has been augmented, and that a greater quantity of electricity at a given tension can become accumulated upon the conductor.

If a cotton thread, a conductor offering a considerable amount of resistance, be attached to the extremity, w, of the wire, and led to earth, it may be shown that the conductor and the surrounding cylinder become charged, assuming opposite tensions, when contact is made at w', with the pole of a battery of which the other pole is led to earth. In a submarine cable, where the extent of the opposed surfaces is very considerable, and the distance between them, which determines the "inductive resistance," *i.e.*, the converse of the capacity for charge, is necessarily small; the quantity of electricity thus accumulated, or absorbed, is sufficient to lower the tension of the battery nearly to zero for an appreciable period of time. From what has been said, it is evident that, under these conditions, retardation of the electrical signals must necessarily occur. But it is not alone in the period necessary to effect the charge of the wire that the retardation of signals takes place. After each signal, the charged wire has to be discharged to earth before a fresh current is transmitted.

En resumé, we have to charge the wire, $w\ w'$, to the full extent of its charging capacity, before we can obtain a constant difference of tensions, between the end of the wire in contact with the battery, and the earth to which its other extremity is led; and we have then to discharge the conductor, or to allow the electricities accumulated upon the opposing surfaces of the dielectric to neutralize each other, before we can send another distinct signal.

We will now adopt the arrangement represented in fig. 2. A number of fibres of baked silk may be wrapped round the wire, $w\ w'$, near each of its extremities, so as to form insulating plugs to be introduced within the ends of the metal tube, $t\ t$, which, thus, will surround the wire without being in electrical contact with it. The wire is then supported as before, within the cylinder C, by means of the perforated dics of insulating material, $d\ d$.

To one of the extremities of the tube, $t\ t$, is attached a wire, t E, which may be attached to an electrometer (tension meter) or a galvanometer (meter of dynamic quantity).

* Page 15, Vol. II.,

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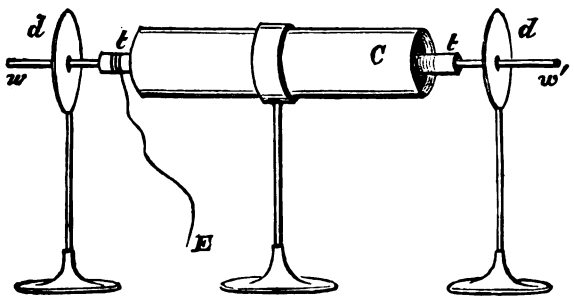
1. Let us attach an electrometer at E, and charge *w w'* from another charged electrometer, as before. No very perceptible difference will, under these conditions, be observed in the capacity for charge exhibited by *w w'*; but, when the latter has been charged to the given tension, the electrometer at E will also be found to be charged, though to a somewhat lower tension.

Fig. 2.



2. Discharge the electrometer at E by touching with the finger, and, subsequently, discharge, in like manner, the wire *w w'*. When this has been done, the electrometer at E will be found again to be charged to the same tension as in the former case, but of the opposite sign.

3. When the electrometer at E is discharged in the former experiment, the indication upon that in contact with the wire will be found greatly reduced, or the instrument will, *apparently*, have been also discharged. The cause of this effect will be readily understood from the fact, that when the wire, *t* E, is connected to earth, the capacity for charge of *w w'* is greatly augmented. If the electrometer at E be repeatedly discharged while the charge of *w w'* is continued, the same condition virtually prevails; and, upon subsequently connecting *w w'* to earth, electricity of comparatively high tension, and of opposite sign to that producing the original inductive, is shown at E.

4. By placing a *gold leaf* electrometer at E, and alternately charging and discharging the wire at *w'*, by means of a De Luc's column, or other tension source, and contact with the finger; it will be seen that a deflection of the leaves occurs both when the wire is charged, or, rather, *while it is becoming charged*, and when it is *discharged* to earth. It may even be shown that the wire requires to be only partially discharged and charged to produce the "reversal." For this purpose, after the wire has been charged by contact with the electric column, we may discharge the electrometer at E, and then partially discharge *w w'* by touching it with a bad conductor, such as a strip of wood, or a thread of cotton, when the leaves of the galvanometer will be found to diverge.

In these experiments, the details of which may be almost superfluous to some of our readers, we merely utilize the known properties of an insulated Leyden arrangement, for the purpose of obtaining an effect, or signal, by induced electricity, instead of by direct conduction.

(To be continued.)

ABSTRACT OF A NOTICE OF THE METHODS OF PRESERVING WOOD BY INJECTION.

BY M. GAUTHIER VILLARS.*

Wood contains azotised albuminous substances, which, under the influence of air and moisture form ferments.

These putrefy and set up decomposition and alteration in the other constituents of the timber, including the woody fibre itself.

This decomposition goes on the more rapidly as the proportion of sap to the woody fibre increases, because of the increase in the quantity of albuminous matter.

If, then, we can expel these fermentable substances, or by means of chemical re-agents, prevent their alteration, we shall also prevent the ulterior decomposition of the other constituents of the wood.

The fermentable parts of timber are analogous in their nature to animal matter, and the same antiseptics which prevent putrefaction in the latter will preserve the former.

Creosote is perfectly efficacious in both cases. Animals placed in the vacuum cylinder are converted into mummies.

Chloride of mercury (Kyan's patent) is useful, but it does not seem to resist the effect of moisture, which washes out the salt. It is very hurtful to the persons who handle the prepared timber.

Chloride of zinc seems, also, apt to wash out. Chloride of calcuim, common salt, sulphate of soda, and many other salts have been tried, but without perfect success.

Sulphate of iron, on the other hand, has a specific effect on woody fibre, because of its acid reaction. By Payn's process the wood is injected with this salt, and the excess over and above that portion of it which enters into chemical composition with the albumen is removed by a subsequent injection of chloride of barium.

This process was tried in Prussia for telegraph poles, but has been abandoned.

Sulphate of copper appears to be eminently useful. It forms, with the albumen, compounds which, if not chemically definite, are, nevertheless, stable, or not liable to change. It remains fixed in the cells of the wood, in such a manner as completely to resist the washing effect of the weather.

The two substances to be compared then, are, *creosote* and *sulphate of copper*, both equally efficacious, when properly applied.

Creosote can only be injected by the vacuum process. Sulphate of copper may be applied, either by vacuum, or by the method of Dr. Boucherie, hereafter to be described.

In the vacuum process the liquid penetrates by the pores of the wood, following the course of the sap vessels, the quantity imbibed laterally being next to nothing.

To produce satisfactory results, it is necessary that the pieces of timber placed in the cylinder should be as nearly as possible equal in porosity, and about the same dimensions, especially as regards length.

The quantity of creosote injected should be 8lbs. per foot cube; that of sulphate of copper 5·5 kilos. per metre foot cube.

Creosoting is very frequently badly performed, a pressure of four or five atmospheres only being used, and occasionally water being mixed with the creosote. The process has, under these circumstances, given bad results, as was the case on the Northern of France and the Strasbourg Railway.

But whenever it has been properly done, under a pressure of from nine to ten atmospheres for five or six hours, the wood being dry, and the liquor good, strict investigation has shown that a remarkable degree of preservation has been attained.

In creosoting we cannot test, by means of chemical re-agents, the degree of preparation which the timber has undergone; and, if the result be incomplete, it is very difficult to prove it, because we cannot get at the interior of the piece, which is the part least impregnated.

It is, therefore, necessary to weigh trial poles before and after the operation. There is a very complete check, however, upon the process of injecting sulphate of copper.

Creosote appears to us to make the timber very liable to break, while copper has clearly been proved by experiment to reduce its strength only two per cent., while it must be borne in mind that unprepared poles lose the greater part of their strength in a very short time.

Creosoting cannot be successfully applied to timber which is not thoroughly seasoned and dry; nor can copper be injected under vacuum, unless the wood is tolerably dry. This is a disadvantage, inasmuch as it is difficult to preserve poles from

*From the *Annales Telegraphiques.*

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incipient decay, *during the process of seasoning*, because of the fermentation of the sap.

Boucherising, on the contrary. is best applied to newly cut trees, allowing the sap *no time to commence fermentation*. It, however, cannot economically be used when the timber has commenced to dry.

In the Boucherie process the liquid penetrates at one end of the tree, driving before it the greater part of the sap and the azotised albumenised matters which it contains.

But under the system of pressure in a closed vessel, whether creosote or copper be used, these substances are not removed except in a very small proportion. It cannot, then, be wondered at, that to prevent their fermentation, and the consequent decomposition of the woody fibre, a very large quantity of the preserving liquid is required.

In the second place, it is necessary to examine if the sulphate of copper, when introduced into seasoned timber (by the vacuum process) fixes itself in as permanent a manner as in green wood. Does wood prepared with copper by vacuum resist the washing action of rain, as well as that prepared by the Boucherie process? Sufficient time has not yet elapsed to test this point. Does not the compound of sap and sulphate resist water better than the sulphate by itself?

The process of Dr. Boucherie is this:—Upon a level piece of land cross pieces are laid to support the ends of the poles, which are placed side by side, the butt ends together—the cross piece supporting the butts should be raised so as to give the poles a slight slope.

Gutters of wood run under each end of the poles to receive the leakage and the liquid which flows from the small end, and carry them to the reservoir under the stage.

A stage from twenty-six to thirty-two feet high is erected, with a platform carrying two or three tubs, which can be placed in communication by means of taps, with a leaden pipe which is carried along the butt ends of the poles, to supply them with the solution under the pressure of a column the height of the stage. In this pipe are as many short copper-tubes as there are poles to be prepared; to each tube is fitted a vulcanised rubber pipe, carrying a mouthpiece of hard wood. A pump is placed on the platform to raise the water for injection, which is to be mixed with sulphate in one or other of the tubs on the stage. The apparatus should be placed near a supply of pure soft water, and sufficiently near to the growing timber to allow of the trees being delivered freshly cut.

The solution of sulphate of copper ought neither to be too strong or too weak. If too weak, the preparation occupies too long a time, and the timber dries before it is finished; if too strong, it leaves, especially at the end by which it enters, an excess of salt, which stops the pores.

The best strength is one part of sulphate to one hundred of water, and to preserve wood effectively, 5·5 kilos should be injected into a cube metre.

To ensure regularity in the strength of the solution, two or more vessels should be employed, either of which may be turned on to the pipes while the others are employed in preparing solution of an uniform strength. The liquid has thus time to settle, which is very essential, as dirt or muddiness of any kind stops the pores of the wood, and hinders its preparation.

The pipes for drawing off the solution should be fixed two or three inches from the bottom of the vessels, and the crystals of sulphate should be placed in a basket hung near the surface of the water in the tubs. A slice must be cut off each end of the tree to remove dirt, resin, &c., and provide a clean open set of pores to receive the liquid.

At the butt end of the tree a small reservoir must be formed to convey the solution into the wood, formed by a packing of india-rubber cord, about $\frac{1}{4}$ or $\frac{3}{8}$ inch thick, nailed by fine copper tacks as close as possible to the outside of the wood, and a plate of hard wood a little larger than the butt, strengthened by a cross bar, is placed on the packing, and is held on by two iron dogs driven into the side of the tree. The fixing this plate requires much care.

It is essential that the packing be laid as close as possible to the outside, or else the outer layer will not be injected, and yet it must be perfectly tight, or it will leak.

In the centre of this plate is a hole to receive the hard wood nozzle of the branch pipe. These branches do not require taps, all that is necessary is to fold back the tube on itself, and tie the two parts together.

When the tube is fixed and untied, a small hole must be made in the packing on the upper side, with a copper awl, to let the air out; when the liquid spirts freely out, it must be closed by a blow with a hammer. The awl can be placed between the packing and the butt, while the packing is being fitted.

The sap commences to flow out at the top of the poles, almost immediately the pressure is put on. This sap is pure at first, but soon becomes mixed with sulphate, getting stronger and stronger as the operation proceeds. It falls into the troughs, and runs into the reservoir at the foot of the stage. A bag or fine wicker basket should be fixed at the end of the trough as a strainer.

After being allowed to settle, the liquid is pumped up into one of the upper vessels and supplied with fresh crystals. Although some copper is always contained in this liquor, the same weight of sulphate is added to it as if it were plain water—one to one hundred parts by weight.

The employment of this return liquor is objectionable on the ground that it contains sap and other matters susceptible of fermentation, but the sulphate neutralises these putrescible substances, and there is no waste of material, as there would be if it were thrown away. Occasionally, the liquor is strong, owing to leakages, &c. Great care must be taken to clear the pipes of air.

Sometimes, notwithstanding all the precautions, air lodges at the upper part of the packing, and prevents the entrance of the solution. The poles should therefore be turned half round some time before the close of the operation, the bubbles then change their place. Frequently, the poles become blocked by resin, or by the deposition of the iron which sulphate of copper always contains, in a greater or less degree; when this is the case, a fresh slice must be cut off.

When the wood is sufficiently prepared, it gives a brown stain when brushed over with a weak solution of yellow prussiate of potash (0·09 kil. to the litre). When there are large knots in the pole, it is well to tar or paint them over, to prevent leakage. As soon as the rest of the pole is sufficiently prepared, the knots may be cut clean, to allow the solution to run through them.

The sap canals of the trunk do not run into, or communicate with those of the branches, but are distinct throughout; so that the latter are not injected, except when the solution penetrates from the butt upwards, not being at all affected when the pressure is put on at the small end of the pole.

Frequently, with long poles, it is difficult to prepare the small end thoroughly. In this case they are turned end for end, and the packing applied at the small end. To prevent the middle of the pole being left unprepared, care must be taken not to turn them until the sulphate has commenced to appear at the small end, and all that is wanted is to complete the preservation of the top.

The height of the stage is a matter of importance, especially when preparing long poles. If it is too low, the pressure is not sufficient to complete the process before the tree has become too dry to take the solution. If too high, the solution passes too quickly through the pores, passing away before it has had time to combine chemically with the sap.

It has been found, that timber prepared with too high a head of solution, has perished very speedily, while a lesser pressure has effectually preserved it. The height of the head will vary

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with the nature of the timber to be prepared; about thirty-two feet is the best height for ordinary poles, but for poles forty feet it should be two or three yards higher.

It is necessary, therefore, not to complete the process too quickly.

For large wood or wood with heart, a special packing must be employed for the heart after the sap wood is finished. But solid heart-wood resists all methods of preparation.

The French administration demand that poles shall not contain more than two-thirds heart; in order that it may be covered with a coat of prepared sapwood.

The following are the points to be attended to in choosing timber for Boucherising.

It is evident that every decayed portion resists preparation.

If bruised or damaged, the solution runs out at the wounds. Scabs resist injection, and should be rejected.

Twisted and crooked trees cannot be properly prepared.

Old trees growing on bad soil, have very little sapwood, and are much less vigorous, though generally straighter than those trees of a similar age which have the air and space necessary for a free development of their tops. The latter are to be preferred.

Whatever the kind of wood, the injection is performed more easily and readily when the sap is most fluid, and flows the fastest; and, therefore, the degree of penetration depends on the season the trees are cut. So also does the time which will elapse between the felling, before the wood becomes too dry for the process, from the coagulation of the sap.

In December, January, February, and March, that is to say, before the leaves appear, the sap is sufficiently fluid; and trees cut during these months, prepare well up to the end of May.

Between 13th April and 1st September, the sap is fermentable, and thick, and as few as possible should be cut, or at least not more than eight or fifteen days at the farthest should elapse between felling and preparation.

After the commencement of September and during the fall of the leaf, the sap is again fluid; and trees cut between the middle of September and the end of November, prepare well any time during the next three months.

During summer it is necessary to protect the timber, as far as possible, from the sun; above all, to avoid their drying on one side.

It is desirable, if practicable, to keep them in water; the water replaces the sap at the ends of the trees, and leaves adhering to the pores, sufficient albumen to combine with the copper, and ensure good preparation. But if the water is muddy, the ends must be recut to afford open pores for the solution.

The time necessary for the process, varies very considerably with the season, the pressure, the time the poles have been cut, and the quality of the timber.

With the same kind of wood, the time is directly proportional to the pressure; inversely proportional to the diameter; and inversely proportional to the square of the length.

Poles of twenty-six feet take five to seven days, when they have been cut some time.*

Poles prepared by the Boucherie process have lasted in a very remarkable manner; one cannot give a more striking example than that of the poles prepared for the French lines, amounting to about 230,000, commencing in 1844.

Among the numberless cases we could cite, we choose the following from the lines first erected.

Out of 800 twenty feet poles on the line, from Hazlebrouck to Lille, which were prepared in 1844 and 1845, and were taken down in 1858, we only found sixteen rotten, and some of these were bad only at the top. They had, probably, not been well prepared throughout. Long poles (thirty-eight feet) have frequently gone at the top, from this cause, after three or four years.

* In Belgium, where they were kept after felling, from two to eight days, about three days was the average time.

The rot spreads from the top downwards, and from the centre to the circumference, forming a funnel-shaped hole. Many of these poles would have been saved if polecaps or roofs had been used, or if the tops had been painted.*

Experiments were made to discover how much copper remained in the sound part, immediately adjoining the limit of rot, and it was found to be about two kilos per metre cube.

But we must remark, that the trials were far too few to establish satisfactorily what is the least quantity that may be used. This point must be studied. We have arrived at the following conclusion from all the observations we have been enabled to make—that when prepared poles decay, it is to be attributed, not to the inutility of the preservative agent, but to faults in the process.

It might be feared that the centre of the pole which has not "taken" the copper may perish as quickly as if the pole had not been prepared, but this is not the case, for the heart is surrounded by a prepared layer of sapwood, which protects it from external influence, and preserves it from perishing, and causing the rot of the heart, as is the case in unprepared poles.

At the butt of the poles the heart has not rotted whether the pole has been in the ground or not, because the heart has received a slight impregnation from the pressure having been applied to that end. If, then, the poles had been turned end for end, and pressure afterwards applied at the small end, the heart would have been preserved there also, as well as the sapwood. †

It has occasionally seemed that timber, badly prepared, has decayed faster than if unprepared, but this effect is principally due to the fact that it has been cut at a season unfavourable to its preservation; and if, in addition, it has received an imperfect injection, it ought, necessarily, to be less durable. When a log has been incompletely injected, the prepared parts have remained sound, though surrounded by rot.

Prepared poles should not be set near chimneys, dunghills, or other places where ammonia, or acid, is given off, as these agents will rob them of the copper. Sleepers prepared and laid in 1846 have remained perfect up to 1855, on the Northern of France Railway.

Finally.—When sulphate of copper is caused to penetrate into green timber, it forms stable chemical compounds, which will not wash out by weather. Poles, properly prepared, lose only the excess of sulphate, which remains simply stored up in them in its natural state. We have even found that poles planted in ditches, almost constantly full of water, will give the characteristic brown colour with ferrocyanuret of potass.

The price per cube meter is as follows:—

	f.	c.
Sulphate, six kilos at 120 cent.	7	20
Labour	4	00
Construction of apparatus, rent, wear and tear, &c.	1	50
Sundries	1	00
	13	70

The royalty payable to the patentee is 3 francs per metre.

Total, 16f. 70c. per metre.

From the "Annual Report on the Belgian Telegraphs," by M. J. Vinchent, Engineer-in-chief, Jan. 1861.

"The poles are injected with sulphate of copper by the Boucherie process. They are chiefly a kind of Scotch fir, with little heart. The result of the process is favourable: several new lines, of one or two wires, were established in 1860, with poles prepared and set in 1850, which were in perfect preservation after ten years' service. They were taken out of the principal lines, because they were too small for the number of wires

* In Belgium, new lines of one and two wires were erected with very small poles, two and a half to three inches in diameter at top, which had been in the ground ten years, but were not strong enough for the number of wires that had been placed on them since they were first set.

† This shows that unprepared heart rots much faster than prepared sapwood.

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then on them, being only about three inches in diameter. To all appearance they will last many years yet. *

"However advantageous the results, the constantly increasing cost will tend to diminish the value of the process. The price of creosote is, on the other hand, reduced year by year, and this circumstance will, probably, induce the administration to try it for a certain number of telegraph poles."

THE INDUCTION COIL.

Abstract of a Paper read before the Society of Arts, in February, 1856.

BY JONATHAN N. HEARDER.

THE medical or galvanic coil machine is an instrument well-known, and requires little description. The forms which have been given to the electro-magnetic coil machine have been of a very diversified character. The principal object appears to have been the production of a shock of various degrees of force, and very little more than this has ever been aspired to. On several occasions, when the conditions have been such as to favour a more than ordinary development of the power of the induced current, unusual effects, such as tension sparks of as much as ½ of an inch in length, have been produced, but until within the last two or three years no attempt has been made to increase these effects.

Having been myself many years engaged in the manufacture of an improved form of the medical coil machine, for which, in 1846, I received the silver medal from the Royal Cornwall Polytechnic Institution, I had often been struck with the exalted statical condition of the secondary terminals, especially in some of my largest machines, although no attempts at insulation beyond the ordinary cotton covering of the wire were made, and often promised myself to try the effect of a more perfect insulation. I was not induced to carry out the experiment until I heard of the effects produced by a machine manufactured by M. Ruhmkorff, of Paris, when I proceeded, in the absence of any definite information about it, to act upon my original suggestions, and construct an instrument upon my own plan.

In order clearly to understand the circumstances which give rise to the extraordinary increase of power in the induction coil, as it is now called for the sake of distinction, it will be necessary to make a brief analysis of the principles involved in the construction of electro-magnetic coil machines in general. They are based upon two facts first discovered by our illustrious Faraday—viz., 1st. When a current of voltaic electricity passes through a metal helix, an inverse current of transient duration takes place in the same wire, in a direction opposite to that of the battery current at the instant when the battery current begins to circulate; and when the battery current is suspended, another wave or current of a similarly transient character takes place in a direction opposite to the first one. 2nd. If the first metal helix be surrounded by a second helix which shall be insulated from and totally independent of it, these secondary waves or currents will be found to take place in the second helix as well as in the first, although none of the battery current passes through it. These effects are greatly enhanced when the helices are made to include an iron bar, or, still better, a bundle of iron wire. These experiments are the foundation upon which all electro-magnetic induction coils are constructed, and their various qualities depend on the judicious adjustment of the two helices and the battery to each other. Induction coils may be considered to consist essentially of three parts, whose functions must be separately examined, viz., 1st., the primary coil, whose office is to conduct a current of dynamic electricity from a voltaic battery. 2nd. A soft iron core intended to take up, concentrate, and radiate the magnetic influences of the battery current. 3rd. The secondary coil, whose function is to develop the electrical effects due to the re-action of any uncontrolled magnetic intensity excited in the iron core.

In the new form of induction coil, another element, and a most essential one, invented by Fizeau, has been introduced, called the condenser, but it is independent of the others, and has not hitherto entered into the construction of the ordinary coil apparatus.

The effect of the passage of the voltaic current through the primary coil is to develop magnetism; whether within the coil or externally to it is a matter of question, though I believe the latter to be the case. If an iron wire be included within this primary coil the magnetism thus developed is taken up by it, and distributed throughout its whole mass, and by this means the core becomes a homogeneous magnet, representing the sum of all the forces of the surrounding coils, which are equivalent to so many little isolated magnets acting under disadvantageous circumstances. This magnetic condition of the iron core being due to the action of the voltaic current traversing the wire, will be modified, not only by the varied character of the current itself, but by any variations in the length and resistance of the wire, and will only last as long as the exciting cause is kept up. This development of magnetism is, however, not the only phenomenon which takes place here, for it was found by Faraday, that as a voltaic current originates magnetic action, so magnetic action itself is capable of giving rise to an electric current, and this latter, being the result of reaction, takes place, as might be supposed, in the opposite direction; so that, in point of fact, when a voltaic current is traversing a wire in one direction and producing magnetism, the wire is also traversed by a second current, due to the reaction of the magnetism, in an opposite direction. It is not very easy to understand how a wire can thus carry two currents at once in opposite directions, unless the currents may be supposed to partake of different natures, which is not at all improbable. This secondary or induced current is, however, extremely transient, existing only during the time occupied in the change of the iron from the normal to the magnetic state; for, after the first impulse, the wire, so far as regards the second current, is neutral.

If a second wire be made to surround either the first helix, or any portion of the iron core, so as to be brought under the influence of its magnetism, induced currents will be excited in it coincident with those of the primary coil, although it shall be perfectly insulated from it. The statical intensity of these currents will be greater in proportion to the length of the wire and the exalted magnetic condition of the core, and if the wire be covered with cotton, and be of considerable length, static sparks may be obtained at the terminals, even though they may be in contact with the wooden portions of the instrument. I had often noticed these effects with my own medical coil machines as early as the year 1842, especially with the more powerful ones, from which bright and vivid sparks were elicited between coke terminals, and Leyden jars could be charged so as to give an appreciable spark and affect the gold-leaf electrometer. Judging from such effects as these, in the absence of any approximation to good insulation, that much longer sparks might be obtained if the secondary wire were perfectly insulated, I had often promised myself to try the experiment, but neglected to do so until stimulated by the improvements of M. Ruhmkorff.

Report says that Ruhmkorff's instruments usually contain from 4 to 5 miles of secondary wire, though some have been made of more than twice this size, and the different coils are, through the intervention of the shellac, so far insulated from each other as to enable the induced current to obtain a degree of tension sufficient to overleap an interval of ½ an inch or more. This increase of power is, however, not entirely owing to the more efficient insulation, for without the addition of the new element, viz., the condenser, the sparks are not one-eighth of an inch in length. Ruhmkorff appears to have satisfied himself that he had obtained pretty nearly the maximum of effect from the quantity of materials which he has employed, since, although it would appear that he has constructed some scores of the instruments, I believe they do not usually give sparks exceeding 5 or 6 tenths of an inch in length. The induction coil, however, as presented to the scientific world by Ruhmkorff, has served to develop an entirely new class of phenomena, and to open a field for investigation of a novel and interesting character. The condenser consists of an extensive surface of oiled silk, or other thin nonconducting tissue, coated on each side with tin foil, after the manner of a Leyden jar, leaving round the tin foil an uncoated margin. This, for economy of space, may be folded into any convenient form, provided the opposite coatings be kept from touching each other. When used, a wire or conducting strip of metal from each coating is connected with the portions of the primary coil where the interruption is made, so that when the current is broken, the interrupted ends are respectively in metallic communication with the opposite coatings of the condenser. What the rationale of its action may be, is at present rather doubtful. The strongest machine without a condenser dwindles into insignificance. Without the condenser the secondary current due to the inductive action of the magnetic change in the iron core, from the active to the passive state, would be divided between the coils surrounding the core. The form which Ruhmkorff has given to his instrument is at once compact, light, and elegant; the coil itself is about 12 inches-long and about 4 inches thick, having plate glass ends, through the centres of which project the ends of the iron core. One end of this core attracts a little iron hammer, which rests on an anvil, the touching surfaces of which are armed with platina. The anvil and hammer, being made part of a circuit, constitute together an interruptor, contact being broken whenever the hammer is attracted up from the surface of the anvil. In addition to this, the instrument is

* We saw these poles, they are mere whip-stalks, but in excellent preservation. Copper has been abandoned for railway sleepers, because when laid in wet soils a chemical action takes place between it and the iron spikes. No such effect has been noticed in telegraph poles.

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furnished with a commutator, for the purpose of reversing at will the direction of the current. The ends of the secondary coil pass out through holes in one of the glass plates, and are connected with binding screws, fastened on the tops of two little glass pillars serving as insulated terminals, with which may be connected any apparatus for the purpose of experiment. The following are a few of the phenomena developed by the instrument. When two small wires connected with the terminals have their free ends brought near to each other, streams of sparks pass between them at a distance varying from 0·4 to 0·6 of an inch when 10 or 12 cells of a nitric acid battery are connected with the primary coil of the instrument. These sparks inflame combustible substances. such as gunpowder, alcohol, gun-cotton, writing paper, cork, &c. When connected with two insulated wires projecting into the interior of a globular or egg-shaped receiver of 5 or 6 inches diameter, a brilliant atmosphere of light is produced on exhausting the air, and when the intensity is carried beyond a certain point, crimson and violet sparks pass between the terminals, some three or four inches in length.

In the machines constructed by myself the coil was six inches in length, and contained about 1½ miles of fine secondary wire; it was wound upon a hollow bobbin of wood, covered with gutta percha, and having its centre large enough to contain the primary coil with its iron core, of which I constructed several modifications, to suit batteries of different electro-motive force. The secondary wire was covered with silk, and the layers insulated from each other with oiled silk and gutta percha. I also made a variety of condensers, and found the following substances well adapted for them, viz., common cartridge-paper, varnished paper, oiled silk, gutta percha, and thin vulcanised india rubber. I likewise varied the form of the condensers so as to bring both surfaces of each sheet of tin foil to act, thereby doubling the inducing surface, and this I effected by placing sheets of tin foil between sheets of the insulating tissue, and connecting the alternate sheets at opposite ends; or by employing an extra insulating layer upon one of the sheets of tin foil, and folding the whole over and over; or again by rolling the same arrangement upon a round roller of wood, &c. With this machine I was enabled to obtain sparks between the terminals more than one inch in length, and charge a Leyden jar containing three square feet of surface, so as to give a torrent of brilliant discharges between platina terminals. Although a very perfect insulation develops a high state of tension in the secondary current, yet even this may be forced too far, just as we may overcharge a Leyden jar, and fracture the glass, for if we attempt to force the instrument beyond a certain point, some portions of the insulation break down, and the electricity, having once made a way for itself, will always pass subsequently with greater facility, thereby lessening the maximum power of the current. Having described the rationale of the action of the induction coil, together with the mode of construction, it now remains to illustrate its action by a few experiments.

Experiment 1. When the terminals of the secondary or induced wire are connected respectively with the wires of an universal discharger, the ends of which are furnished with pointed platina wires to serve as electrodes, bright thick crepitating sparks pass between the platina points when they are brought within a certain distance of each other, and with a powerful machine and a battery in good action, the points may be separated nearly four inches, when the sparks assume a zigzag character.

Experiment 2. If, whilst sparks are passing between the points, the condenser be disconnected, the sparks disappear, but reappear on connecting it again.

Experiment 3. If, when sparks are passing at the distance of half an inch, the points be gradually approximated, one of them, viz., that forming the negative electrode, will become red, and even white hot, and if the machine be powerful, both become ignited on a nearer approximation to each other.

Experiment 4. If the points be placed beyond the striking distance, sparks and brushes of light will be seen passing from the positive electrode, over a portion of the interval, and the negative electrode will be illuminated by its characteristic star of light, also throwing off smaller brushes, which re-curve over the wire, and either terminal will give sparks to an uninsulated conductor brought near to it, which will be longer if the opposite terminal be connected with the ground.

Experiment 5. If the flame of a spirit lamp be placed between the points of a discharger, the sparks will pass several inches through it, and with one of my powerful machines, sparks of a foot or more in length may be obtained in this way through the flames of several spirit lamps placed side by side.

Experiment 6. When sparks are passing between the terminals at a distance of about half an inch, combustible substances such as paper, cotton, &c., may be kindled by being introduced between the points.

Experiment 7. If we place the points of the universal discharger three or four inches apart, on the surface of a piece of soft wood or cork, which has been previously moistened with a little sulphuric or nitric acid, the substances are ignited and kindled into flame about the points of the discharger.

Experiment 8. If metallic filings be fastened by varnish upon the surface of a plate of glass, sparks ten or twelve inches in length may be passed over them, the colour of which will vary according to the metal used.

Experiment 9. If the two wires leading from the terminals of the coil to the universal discharger be connected respectively, one with the outer, and the other with the inner coating of the insulated Leyden jar, the sparks between the points of the discharger will be much shorter, but they will be very much louder and brighter, assuming quite the character of the Leyden discharge.

Experiment 10. If a portion of gunpowder be now placed upon the table of the universal discharger, it will not be inflamed by the spark of the jar, but will be dispersed, as in ordinary frictional electricity.

Experiment 11. The length of the spark and its strength when the Leyden jar is used, will depend upon the size of the jar. The smaller the jar the longer the spark, but larger jars give shorter and louder sparks.

Experiment 12. If these discharges be made to pass through an iron chain of ten or twelve feet in length, suspended in a festoon, sparks accompanied with brilliant scintillations will occur at every link.

Experiment 13. If the discharges of the jar be made to pass through a large lump of loaf sugar, a crystal of alum, &c., these crystals will be splendidly illuminated.

Experiment 14. If a Leyden jar, covered with detached diamond-shape spots of tin foil, be insulated and connected with the terminals of the coil, it will be brilliantly illuminated during the whole time that the machine is in action.

Experiment 15. If a plate of glass be coated on one side with tin-foil, leaving an uncoated margin of glass, and on the other side be only partially coated, the tin foil being laid on in the form of a star or other device, this will be surrounded with a beautiful light fringe of electric light when connected with the machine, and, at the same time, a most powerful odour of ozone will be given off.

Experiment 16. Coat a large glass flower vase, from eight to ten inches high, internally with tin foil to within an inch or two of the top, and place it on an air-pump. Cover it with a receiver having a sliding wire passing air-tight through the top of it; let the wire be depressed so as to touch the tin foil coating of the glass. Connect the outer end of the wire with one terminal of the coil, and the pump-plate with the other terminal. When the machine is in action a splendid cascade of electric light will be seen flowing over the edge of the glass, and apparently falling on the pump-plate when the upper wire is made positive, but when the current is reversed the electrical appearances undergo a marked change, and the current appears to flow upwards instead of downwards.

Experiment 17. If a tall receiver, from two to three feet in height, having a cap and sliding wire on the top, be placed on the air-pump and the air exhausted, a splendid aurora borealis fills the tube with corruscations.

Experiment 18. If this experiment be modified by partially filling the receiver with hydrogen gas and exhausting again, the electrical appearances are very beautiful, the light in the interior appearing intersected by dark bands, which arrange themselves in a symmetrical form.

Experiment 19. Place in the circuit, between the two terminals of the induction coil, Harris's thermo-electrometer. Connect also in the circuit Lane's discharging electrometer, for the purpose of modifying the length of the spark. Pass a current thus through the electrometer and no effect will be observed.

Experiment 20. Now insulate a Leyden jar and connect its outer coating, by means of a wire, with one of the terminals of the coil, and its inner coating with the other terminal, all the other connexions of the former experiment remaining as they were. On adjusting the points of the discharger, so that the sparks may pass, the wire will now be found to be heated, the amount of heat produced being pretty nearly in the simple proportion of the coated surface of the jar. This law appears to be quite new.

Experiment 21. The apparatus being arranged as in the previous experiment, place a little gunpowder between the points of the discharger and it will not be inflamed, but simply dispersed, though the wire in the electrometer will be heated. Now insert a wet string between the discharger and the electrometer, and on passing the discharges the gunpowder will be inflamed, but the electrometer will not be heated.

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Experiment 22. If instead of the thermo-electrometer a piece of fine iron wire, about two or three inches long, be placed in the circuit, it will be instantly fused when the discharges pass.

The induced current thus appears to be considerably modified in its character by the intervention of the Leyden jar, and the nature of this change may be beautifully shown by the following arrangement:—

Experiment 23. Connect a thermo-electrometer and a Lane's discharging electrometer with the terminals of the coil. Upon an adjoining table place a disc of wood covered with tin foil, exposing a flat surface of five or six square feet, and connect it also with one terminal of the coil. Take a second similar disc of wood, coated with tin foil, and suspend it over the first one, by means of a string, passing over pulleys in a frame so constructed as to admit of the second disc being raised to the height of five or six feet above the lower one. Connect this disc by means of a flexible wire with the other terminal. If now the upper coated disc be gradually lowered, the sparks rapidly increase in power, and when they are within three or four inches of each other, the sparks assume the character of the discharges of a Leyden jar, and the thermometer begins to be affected. As the discs are gradually lowered still further, their faces being kept parallel to each other, the sparks become still louder, and the thermometer rises 15 to 20 degrees, the dics thus acting as coatings to a charged plate of air. The difference in the thermal properties of the induced current, with or without the intervention of the Leyden jar, is shown by the following experiment:—

Experiment 24. Insulate a Leyden jar, and apply to it a Lane's discharger, connect between the discharger and the outside of the jar a thermo-electrometer, so that the disharge of the jar may pass through it. Insert two other thermo-electrometers respectively in the portions of the circuit which are to conduct the electricity from the terminals of the coil to the inner and outer coatings of the jar, so that the course of the electricity may be assumed to be as follows:—from one terminal of the coil through one thermo-electrometer to the inside of the jar, thence through the discharger and thermo-electrometer connected with it to the outside of the jar, and lastly, from the outside of the jar through the remaining thermo-electrometer to the other terminal of the coil. Now set the machine in action, and the electrometer which connects the two coatings of the jar will show a rise of temperature, whilst the two electrometers which serve to conduct the current between the coil and jar are not in the slightest degree affected. Since the Leyden jar, under the influence of the coil, is capable of producing the same class of effects as when charged by the common electrical machine, we have thus a link of connection opened which may one day serve to establish some relation between equivalents of frictional and voltaic electricity.

I trust that the few experiments laid before the Society are sufficient to show the character of the new instrument, but as to the extent of its capabilities, or the degree of extension of which its principles may be susceptible, time and experiment alone must decide the point. I cannot conclude, however, without alluding to some practical purposes to which the machine appears eminently adapted. The first and most important is its use as an electro-motive agent for the electric telegraph.

The next important use to which it may be applied is for firing charges of gunpowder at a distance.

A third application of it would be for the purpose of electro-metallurgy, but the secondary coil of the instrument would require some considerable modification to adapt it efficiently to this purpose.

I trust that I have now said enough to commend the instrument and the phenomena which it produces to the attention of the scientific world, and I feel quite satisfied that the principles will one day be developed to an extent of which at present we have no conception.

The Student.

THERMO-ELECTRICITY.

FROM the want of a little familiar instruction, seldom to be found in books, thermo-electricity often appears to the student the least satisfactory in its results of all the branches of electrical science. We have, indeed, a painful remembrance of its being so in our case. Having constructed with great care a galvanometer with several hundred turns of fine wire, we formed a thermo-electric couple—which afterwards proved to be very efficient; but it was in vain we endeavoured to obtain the slightest indication of a current. Nor were we more successful when six couples were arranged in series; and we were almost inclined to adopt the conclusion that Professor Seebeck, the illustrious discoverer of thermo-electricity, and all subsequent investigators, had been unaccountably mystified in their conclusions, when we accidentally found that the needle of a galvanometer coiled with but *one* yard of stout wire was deflected by the single couple.

It is necessary, therefore, at the onset, to inform the reader that thermo-electric couples and batteries, though capable of producing a current of considerable quantity through a circuit of small resistance, are, in general, very deficient in tension, or the power of overcoming resistance. In choosing or constructing a galvanometer for the measurement of thermo-electric currents, we cannot, therefore, estimate the delicacy of the instrument by the length of wire in the coil. Being limited in this respect, we may avail ourselves of another means of increasing the sensitiveness, by employing a compound needle carefully rendered *astatic*. Those who may desire to construct an "astatic galvanometer" will find sufficient information for the purpose in a former number;* but very perfect instruments adapted for the study of thermo-electricity may be obtained, at a moderate price, of Messrs. Elliott, in the Strand, and probably also of other philosophical instrument makers.

In the following plan of constructing a thermo-electric couple and circuit, the use of a separate galvanometer is dispensed with. Procure a flat bar of bismuth, about six inches in length and half an inch in breadth, and of sufficient thickness to avoid its easily breaking. Next take a strip of stout copper of the same breadth, and seven inches in length; bend it at right angles near each end, and solder it to the bar of bismuth near the extremities of the latter, so as to form a rectangular frame about half an inch in height. A magnetized needle is now to be poised in the interior of the frame, upon a pivot placed in the central portion of the bar of bismuth. Upon heating one of the soldered junctions by means of a spirit lamp, the needle will be deflected, indicating a current traversing the circuit in the direction from the bismuth to the copper through the *heated* junction.

Our early experience reminds us that it is sometimes difficult to obtain a piece of bismuth of the required form. As we do not wish any such difficulty to stand in the way of experiment and progress in practical knowledge, we will describe a means we have adopted for rendering evident the current produced in combinations far less powerful than the above, but in many cases very readily constructed. The pivot in the middle of the bar of bismuth, or whatever metal we may choose to substitute for it, is dispensed with, and in its place we have part of a sewing needle, three-quarter of an inch in length, the point of which is passed through a hole drilled through the copper strip, and plays in a slight depression made with the point of a file in a small piece of copper attached with gutta percha or shellac, in the place of the pivot, to the bismuth, Two magnetic needles, powerfully and equally magnetized, are attached to the fragment of sewing needle as an axis, one above, and the other below the copper strip, with their poles disposed in opposite directions. An astatic combination is thus formed, which with very little care and labour may be poised with great delicacy. The magnetic needles, which are best made of a thin plate of steel of a lozenge form, should have a small hole drilled through the centre, through which may be passed the needle which serves as an axis.

As may be seen from the following table, in which each metal assumes the negative tension when heated in conjunction with one placed below it in the series, and *vice versa*—German silver or nickel, with copper, zinc or iron, form powerful combinations, while tin or lead, with zinc or iron, constitute less powerful arrangements. The currents generated in the latter will, however, be readily shown by the astatic compound needle.

Thermo-electric Series.

Bismuth	Tin
German silver	Lead
Gold	Brass
Nickel	Copper
Platinum	Zinc
Palladium	Iron
Cobalt	Arsenic
Manganese	Antimony.
Silver	

It will be remembered that, in the voltaic battery, the negative *element* constitutes the positive *pole* of the couple. In imitation of the terms employed in this case, the metals placed first in the above series, although constituting the negative pole in a thermo-electric couple, are generally said to be positive to those which follow. A proper understanding of this point of theory is necessary to avoid future error and confusion.

In the thermo-electric couple and circuit already described, the

* P. 9, Vol. ii.

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deflection of the needle produced by heating one of the surfaces of junction, may be increased by cooling the other surface of junction, or soldered portion. Indeed, a current may be produced by simply cooling one of these surfaces, by means of a few drops of ether poured on a piece of cotton wool wrapped round the metal, or with a fragment of ice. Other things being equal, the quantity of electricity circulating is proportionate to the difference of temperature between the two surfaces of junction.

The thermo-electric couple of Pouillet is composed of a stout cylindrical bar of bismuth, to the extremities of which, bent downwards at right angles, are soldered two stout copper wires. One end of the cylinder may thus be immersed in water containing ice, or at 32° Fah., and the other extremity in water at 112° Fah. The copper wires being then connected to a galvanometer, a current will be indicated in the direction through the wire from the heated to the cooled portions. A number of these couples may be arranged in series, by connecting the copper wires, and immersing the soldered extremities of the bismuth cylinders in vessels of cold and hot water alternately.

A thermo-pile constructed by Professor Botto, of Turin, and sufficiently powerful to effect the decomposition of acidulated water, was formed of 180 pieces of platinum wire, and the same number of pieces of soft iron wire, welded together end to end. The compound wire was coiled round a wooden roller of such diameter that the alternate surfaces of junction should be in the same line, *i.e.*, the first, third, fifth, and all the odd welds on one side of the roller, and the second, fourth &c., on the other side. By heating one set of junctions, while the other set were preserved at the temperature of the air or artificially cooled, a current of comaratively high tension was produced.

In adapting the same arrangement, Poggendorf substituted German silver for the platinum wire with some advantage, German silver being very positive in the scale, as it immediately follows bismuth.

(To be continued.)

CHEMISTRY OF FOOD.

Abstract of a Paper read before the Society of Arts.

BY DR. LETHEBY.

THE statistics of crime, disease, mortality, and even of the general prosperity of a country, are intimately associated with all that concerns the supply of food to the people; the question, therefore, of the economy of food, by which I mean the facts of its production, distribution, and proper appropriation, is of great importance.

Hardly twenty years have elapsed since chemists and physiologists began to turn their attention to the composition of food, and the uses of its several constituents; but in the course of that time, the labours of Prout, Liebig, Dumas, Boussingault, Playfair, Johnston, Mulder, Lehmann, Persoz, Bernard, Payen, and others, have developed a body of facts, which, although of gigantic proportions, may yet be comprehended in a very simple expression, namely, that the various alimentary substances made use of by man and animals, contain at least four classes of constituents, each of which performs its own assigned function in the living animal economy. If the substance contains nitrogen, it usually serves for the nourishment of tissue, and is called plastic or nitrogenous; if it is deficient in nitrogen, but has an excess of carbon or hydrogen, it then undergoes combustion in the body, and is called the non-nitrogeneous or respiratory; if it is fatty in its nature, it performs the double duty of maintaining animal warmth, and of assisting in the assimilation of nitrogeneous compounds, and, lastly, if it is saline in its quality, it goes to build up the solid textures of the animal frame, and also does the important work of carrying new materials into the system and old ones out of it. Man and animals are alike in this particular—that they cannot live upon food which does not contain all these classes of constituents. Experience and common instinct tell us also, that these classes must be associated in due proportion.

A glance at the following table will show that different kinds of food contain different proportions of the four proximate principles to which I have referred; and, if we regard human milk as the type of model of what our food should be, it will be seen that whenever we partake of any aliment that is naturally deficient in one or more of these principles, we endeavour to increase it by art, as by using it with some other food which is rich in the defective substance; but when through force of circumstances, or through a distorted taste, the natural instinct for such adjustment cannot be gratified, or is foolishly thwarted, the health is endangered, the constitution gradually altered, the temperament modified, life shortened, families extinguished, and whole races of men swept from the face of the earth.

NUTRITIVE VALUE OF FOODS.*

Substances, 100 parts.	Water.	Fibrine, Albumen, &c.	Starch, Sugar, &c.	Fat.	Salts.	Carboniferous.	Nitrogenous.	Total Nutriment.
Human Milk	89	3·5	4·2	3·0	0·2	11·4	3·5	14·9
Cows' Milk	86	4·5	5·0	4·1	0·7	14·8	4·5	19·3
Skimmed Milk	87	4·5	5·0	2·7	0·7	11·5	4·5	16·0
Butter Milk	87	4·5	5·0	0·5	0·7	6·0	4·5	10·5
Beef and Mutton	73	19·0	—	5·0	2·0	12·0	19·0	31·0
Veal	77	19·0	—	1·0	0·6	2·4	19·0	21·4
Poultry	74	21·0	—	3·0	1·2	7·2	21·0	128·2
Bacon	20	0·8	—	70·0	1·3	168·0	0·8	168·8
Cheese (Cheddar)	36	29·0	—	30·0	4·5	72·0	29·0	01·0
,, (Skimmed)	44	45·0	—	6·0	5·0	14·4	45·0	159·4
Butter	15	—	—	83·0	2·0	199·0	—	99·0
Eggs	74	14·0	—	10·5	1·5	25·0	14·0	39·0
Whites of Eggs	78	20·0	—	—	1·6	—	20·0	20·0
Yolk or Egg	52	16·0	—	30·0	1·3	72·0	16·0	88·0
White Fish	79	19·0	—	1·0	1·2	2·4	19·0	21·4
Salmon	87	17·0	—	4·0	1·4	9·6	17·0	26·6
Eel	80	10·0	—	8·0	1·3	19·2	10·0	29·2
Wheat Flour	15	11·0	70·0	2·0	1·7	74·8	11·0	85.8
Barley-meal	15	10·0	70·0	2·4	2·0	75·8	10·0	85·8
Oat-meal	15	12·0	62·0	6·0	3·0	76·4	12·0	88·4
Rye-meal	15	9·0	66·0	2·0	1·8	70·8	9·0	79·8
Indian-meal	14	9·0	65·0	8·0	1·7	84·2	9·0	93·2
Rice	14	7·0	76·0	0·3	3·0	76·7	7·0	83·7
Harricot	19	23·0	45·0	3·0	3·6	52·2	23·0	75·2
Peas	13	22·0	58·0	2·0	3·0	62·8	22·0	84·8
Beans	14	24·0	44·0	1·4	3·6	47·4	24·0	71·4
Lentils	14	29·0	44·0	1·5	2·3	47·6	29·0	76·6
Wheat Bread	44	9·0	49·0	1·0	2·3	51·4	9·0	60·4
Rye Bread	48	5·3	46·0	1·0	1·4	48·4	5·3	53·7
Potatoes	74	2·0	23·0	0·2	0·7	23·5	2·0	25·5
Green Vegetables	86	2·0	4·0	0·5	0·7	5·0	2·0	7·0
Arrow-roots	18	—	82·0	—	—	82·0	—	82·0

A healthy vigorous man consumes annually about 704 lb. of solid matter in his food, and yet the weight of his body remains constant. This large amount of food has therefore not contributed to the bulk of his frame, but has evidently been expended in the manifestation of force. It is true that during the whole time portions of his system have been constantly undergoing change—that they have been worn out by labour, and as constantly repaired by food; but to disentangle the subject from all such complicated phenomena, it is evident that the ultimate destiny and purpose of the food has been the development of force.

Experiments on healthy men have shown that the daily consumption of the two principal elements of food—namely, carbon and nitrogen, are about 5,500 grains of the former, and 125 of the latter. These are contained in a diet composed of 12 oz. of beef and 20 oz. of bread, with about half an ounce of butter. According to some authorities, this quantity of food has, for an ordinary machine, a thermotic power capable of raising fourteen millions of pounds one foot high; but we find that when it is consumed in the animal machine, and that, too, under the most advantageous circumstances, the power is not more than three-and-a-half millions of pounds to the height of a foot. Even this is excessive labour; for, to judge from the work done by an active labourer, or by a strong criminal at the treadmill, it rarely exceeds two millions of pounds; in fact, the last worthy only lifts about one million of pounds to the height of a foot every day. Assuming, however, that a ration of food containing 5,500 grains of carbon, and 125 of nitrogen, is capable of developing enough available power in the human system to raise a weight of one million pounds a foot high, we have then a standard of working power by which we may estimate the labour value of the several dietaries now in use.

Human milk may be regarded as a model food. From that we conclude, that the proportions of the several constituents of food which are best suited for the wants of the animal system, are one part of the plastic to about three of the respiratory, and in the case of the physiological ration to which I have alluded, viz., the 12 oz. of beef and 20 of bread, with half-an-ounce of butter, these are the proportions in which they are combined; but an examination of the table which I have drawn up will show that these proportions rarely occur in any single aliment. Hence, the necessity for associating different articles of food so as to obtain the results indicated in the standard.

A very little attention to the proportion of the several nutritive elements, as expressed in the table, will indicate the kinds of combinations that should be effected in order to secure the proper proportions of the model or physiological standard. But here also the application of science must be controlled by practice, for the nutritive power of alimentary substances depends also on their strength, their

* In this Table the carboniferous matter is calculated as starch; 10 of fat being equal to 24 of starch.

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cohesion, and their digestibility, and frequently a substance rich in alimentary principles, but difficult of digestion, nourishes less, and produces less strength than another matter easily dissolved by the digestive juices.

The smallest amount of food on which a healthy man can exist and that only for a short time, is the punishment diet in prisons of a pound of bread a day with water. This furnishes 8·2 parts of respiratory, and 1·4 of plastic. But little less nutritive is the diet, supplied at the county and borough gaols of England to the prisoner who is to be confined for a period of not more than seven days. His daily rations of bread, meat, and milk, contain only about 2 oz. of plastic matter and 12·4 of respiratory. Next in the series are the dietaries of the county and borough prisons when the prisoner is confined for more than two months, and is not kept at hard labour. These furnish about 16 oz. of solid respiratory matter, and 3·1 of plastic. In the Scotch prisons the amounts are 19 oz. of the former, and 3·4 of the latter; while in the Irish gaols it is 20·5 and 3·4. When the prisoner is employed at hard labour the dietary in the English prisons is 3·5 oz. of plastic, and 18·2 of respiratory; in the Irish it is 3·6 and 22 0; and in the Scotch, it is 4·5 and 27·0. The Unions of England employ dietaries which are exceedingly variable, but the daily average of them is 2·8 oz. of plastic, and 14·2 of respiratory. This is somewhat less in nutritive value than the dietaries furnished to destitute debtors; for the average of these is 3·1 oz. of plastic matter, and 16·3 of respiratory, so that the poor man who has to seek parish relief after the hard struggle of a long life, is actually worse provided for than he who, by careless or improvident habits, has become the inmate of a prison. And worse still, the convict whose crimes have made him a curse to society, and whose labour while in prison does not produce above £2 10s. a-year, is carefully tended in a comfortable home, and has daily a rich diet of 3·6 oz. of solid nitrogeneous matter, and 18·4 of respiratory. In short, as the table will show, the day's ration of an unfortunate inmate of a union is only about 33⅜ oz. in weight, whilst that of the debtor is 38 oz., and that of the convict is nearly 48 oz. Such a contrast in the comforts of the three classes is remarkable, and we cannot fail to see in it an encouragement to crime; in fact, when an unusual want presses upon the poorer classes, the effect of this temptation is seen in the crowding of the public gaols.

DIETARIES AND THEIR NUTRITIVE VALUES.*

	Weekly Consumption in Ounces.							Daily Ditto.		
	Bread or Biscuit.	Meat.	Potatoes.	Meal, &c.	Milk.	Cheese.	Butter.	Carboniferous.	Nitrogeneous.	Total Solid Nutriment.
Physiological	140	84	—	—	—	—	3·5	12·7	4·0	16·7
Prison Punishment	112	—	—	—	—	—	—	8·2	1·4	9·6
English County and Borough Gaols :—										
Under 7 days	121	—	—	23	39.5	—	—	12·4	2·2	14·6
Not hard labour	172	7·8	3·2	22·8	15·4	3·5	—	15 7	3·1	18·8
Hard labour	163	14·6	63·4	27·2	41·6	1·5	—	18·2	3·5	21 7
Scotch Prisons :—										
Under 3 days	112	—	—	28	—	—	—	11·2	1·9	13·1
Not hard labour	30	7·5	152	73	175	—	—	19·0	3·4	22 4
Hard labour	76	10	176	100	175	—	—	27·0	4·5	31·5
Irish Prisons :—										
Under 1 month	56	—	192	70	70	—	—	19·5	2·9	22·4
Not hard labour	56	—	192	60	170	—	—	20·5	3·4	23·9
Hard labour	64	—	219	70·5	170	—	—	22·0	3·6	25·6
Military Prisons :—										
Under 84 days	56	—	—	119	210	—	—	22·2	3·8	25·8
Over 84 days	56	—	—	168	210	—	—	27·8	4·7	32·5
Destitute Debtors	156	16	52	22	21	—	—	16 3	3·1	19 4
Convict Prisons	161	36	112	12	12·8	—	—	18·4	3·6	22·0
Unions (Adults)	112	15·5	51	17	34	5·2	1·1	14·2	2·8	17 0
Unions (Children)	90	14	32	—	105	—	3·5	11·1	2·3	13·4
Lunatic Asylums	114	23	68	16	14	7	1·3	13·2	4·0	17·2
Public Hospitals	93	52	56	14	7	—	3·2	12·1	3·5	15·6
Army :—										
Crimea	112†	112	—	—	—	—	—	14·5	4·8	19·3
Home	168	84	112	—	—	—	—	19 4	4·8	24·2
Madras	112	112	56	4*	—	—	—	16·5	4·9	21·4
Bombay	140	112	56	56*	—	—	—	22·2	5·6	27·8
Field (India)	168	—	—	168*	—	—	—	30·7	3·8	34·5
Navy	112†	112	56	—	—	—	—	17·7	5·0	22·7
Navigator (Crimea)	140	140	—	28	—	—	—	17·8	6·2	23·0
Navigator (Home)	320	96	64	—	—	12	4	18·6	7·7	26·2
Berwickshire labourer	122	—	—	224	224	—	—	37·1	7·0	44·1
Yorkshire labourer	280	126	28	—	210	—	49	42 2	8 8	51·0

In the military prisons of England the dietaries for long imprisonments furnish 4·7 oz. of plastic matter, and 27·8 of respiratory, while the food of the prisoner who is confined for a period of less than 84 days contains 3·8 oz. of plastic matter, and 22·2 of respiratory. With this diet the prisoners generally lose weight; in fact, out of a total number of 3,420 prisoners that were discharged from the military prisons in 1854, there were 2,952 that had lost an average weight of 7 lb. 9 oz. per man; only 304 had gained in weight, and they acquired an increase of 2 lb. and 13 oz. per man; the rest had not altered in weight at all.

The ration of the British soldier varies with circumstances. Thus the home ration contains 4·8 oz. of plastic matter, and 19·4 of respiratory. At Madras, it contains 4·9 of the former, and 16·5 of the latter; at Bombay it is 5·6 and 22·2; while the field rations in India contain 30·7 oz. of respiratory, and 3·8 of plastic. The rations in the Crimea were only 14·5 oz. of the former, and 4·8 of the latter. This amount of the plastic material is the same as that contained in the soldier's rations when at home or in the colonies; but it is considerably less than the Bombay rations, where the soldier has not necessity for the food which his great exertions demanded in the Crimea. The dietaries of sailors contain 5 oz. of nitrogeneous matter, and 17·7 of carboniferous.

(*To be continued.*)

* In this Table only the most important articles of diet are mentioned, although the others, excepting beer, spirits, tea, and coffee, are calculated in the daily consumption. (*) are rations of rice, and (†) are of biscuit. Gruel is calculated at the rate of 2 oz. meal per pint.

ON THE PREVENTION OF DECAY IN TIMBER.

AN interesting essay on this subject, has recently been published by M. de Lapparent, Inspector-General of timber for the French navy. The preventive means which may be employed, are classed by the author as follows :—

1. Preventing the stagnation of air in contact with timber.
2. Preventing contact with air in confined spaces.
3. Preparing the surface of the timber in such a manner, as to prevent the growth of fungi.
4. Impregnating the air in contact with the timber, with a substance destructive of the sporules of the fungi.

The two first methods relate exclusively to the preservation of timber in vessels, and similar works of construction, the third and fourth are more generally applicable, and may be found useful for the prevention of decay in the poles used for aerial lines of telegraph.

The carbonization of the surface of timber, is one of the best and cheapest means of protection. When the wood has been seasoned by exposure to the air, the effect of artificial heat, properly applied, is to carbonise the outer layer, forming beneath it a scorched surface, impregnated with the products of the distillation of wood, which are creosoted and impyreumatic, and consequently highly antiseptic.

Why is not this excellent method more generally adopted? This is, says the author, owing to many causes;—the difficulty and danger of the means adopted for charring, when either straw, fern, or shavings are made use of; the serious objections of burning the timber too deeply; or the incumberance of the apparatus, and the length of the time occupied, if sand-kilns sufficiently heated are used; and finally, to indifference, or that system of routine against which the wisest plans so often contend in vain.

The methods of carbonisation which the author first employed at Cherbourg, and which, by the order of the Minister of Marine, are about to be extended to all the dockyards of the French empire, are free from these objections, and realise, on the contrary, all the conditions to be desired, whether of simplicity, facility, safety, or economy. They are as follows :—

A gaspipe is brought into the dockyard. An india rubber tube is screwed on, the other end of which, furnished with a joint, should be fixed at the side of the bench at which the men work. To this joint another end of a tube of sufficient length is fixed, and on that a little brass end is placed, similar to that of a fire-pump, but having inside a small pipe communicating with the reservoir of a foot bellows on the bench. The object of this bellows is, first, to mix with the gas the air necessary to obtain a complete combustion; and, in the second place, to impinge on the jet of flame such a force that it may be directed every way, and made to act not only on the surface of the wood, but in the holes, joints, bolts, mortices, &c., and in general on every part of the timber. The combustion takes place with the most perfect regularity, and, as can be proved, without the least danger, which, be it understood, does not exclude the precautions commonly prudent to adopt whenever fire is employed either on shipboard or in the dock yard.

The results obtained from experiments at the gasometer at Cherbourg, with the aid of a meter, and using a jet of average force, are :—

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1st. That the consumption of gas would be about 200 litres per square mètre, or 200 gallons per 10 square feet of carbonised surface.

2nd. That a workman in an average day's work of 10 hours, would carbonise a surface of 40 square mètres, or 440 square feet.

3rd. That one workman is sufficient for a bellows supplying two jets of gas.

It may, therefore, be admitted that, at full work, the expense would not exceed 15 centimes (1½d.) a square mètre, or 10 square feet. Besides, as has been ascertained by experiment, the operation can be facilitated by smearing, in the first instance, the surface of the timber with a little tar. By so doing these other advantages are gained :—

1st. The carbonisation of the cracks, that almost always occur on the surface of rough timber, is facilitated.

2nd. It prevents the timber being affected too suddenly by the heat of the gas, which causes it to split.

3rd. It prevents the cracking and splintering off of little ignited particles.

But beyond a mere facing of tar we must not go ; a little thicker layer would impede, instead of furthering, the operation. Besides, we must stop as soon as the surface is freely carbonised, which shows that none of the parts below have escaped the charring—which is, I repeat, the end we seek. Under these circumstances, the depth carbonised will not exceed a third or a fourth of a millimètre.

By carbonisation a practical and economical means is offered to railway companies of preserving, almost for ever, the sleepers, particularly oak, which cannot he impregnated by the injection of sulphate of copper. Let us suppose, for instance, that after, say ten or fifteen years, the sleepers on a line are taken up for the length of a mile, and replaced by new ones, the old, when rasped and burnt again, will serve for the replacing of the following mile, and so on, one mile after the other.

In the place of coal gas, the cost of which is comparatively great, carbonic oxide gas may be advantageously employed; for while, on the one hand, its illuminating power is very weak, its heating power, on the other, is very great.

In regard to the means for impregnating the air in contact with timber, with a substance capable of destroying the sporules of fungi, or of impeding their growth, M. de Lapparent has employed a species of paint composed of flour of sulphur, and linseed oil. We know that when paint dries, to use a common expression, it is not by evaporation similar to that which water undergoes, but rather from the effect of a real combustieu of the oil by the oxygen of the air, the result of which is a kind of solid resin ; and it appeared to the author probable that the sulphur, having itself a great affinity for oxygen, would participate in that combustion from which would be generated sulphuric acid. These anticipations were fully realised. The planks painted for experiment emitted sulphurous vapours, and turned to red some strips of litmus paper previously moistened and subjected to the exhalations. Some logs of oak, painted in the same way, were buried in a dung-heap ; six months afterwards the wood appeared perfectly intact, and exhaled a strong sulphurous odour, the action of which had, without doubt, prevented the formation of fungi.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—In answer to your correspondent, "Inquirer," who desires a rule to find the diameter, and resistance of copper and iron wires. Put x for the diameter required ; s, the specific gravity of the metal ; l, the length in inches ; w, the weight in ounces ; c, the number of inches in a cubic foot ; and $n = \cdot 7854$. The specific gravity of copper is $= 8800$; and the number of inches in a cubic foot is $= 1728$.

1. Therefore, $x^2 \times n \times l$ = the number of cubic inches in a given length of wire.

Then, as $c : s :: x^2 n\ l : w$

$$s \times x^2 l\ n = c\ w$$

$$x^2 l\ n = \frac{c\ w}{s}$$

$$x^2 = \frac{c\ w}{l\ n\ s} = \frac{1728 \times w}{l \times \cdot 7854 \times 8800} = \frac{\cdot 25 \times w}{l}$$

$$\therefore x = \sqrt{\frac{\cdot 25 \times w}{l}} \text{ diameter in inches.}$$

Example.—100 yards of copper wire weighs 15 ounces, what's the diameter? substitute d for x ; then $d = \sqrt{\frac{\cdot 25 \times 15}{100 \times 36}} = \frac{1 \cdot 9367}{60} = \cdot 03227$, the diameter in decimals of an inch.

2. The resistance, according to the law of "Ohm," is expressed by the following formula :—

$$R = \frac{L\ C}{S};$$

by which we can calculate the resistance of any metallic conductor, or cable, whose specific resistance is given. Now, by the question, one mile (1,760 yards) of copper wire, having a diameter $D = \cdot 0625$ in., is stated to have a standard *unit* of resistance $= R$. Also, how many such units would there be in 1 mile of copper wire, whose diameter d is $= \cdot 0042$ inches. Substitute D^2 for S in the above formula ; let r represent the number of units required :—

Therefore $\frac{L\ C}{D^2} : R :: \frac{L\ C}{d^2} : r = \frac{D^2 \times R}{d^2} = \frac{(\cdot 0625)^2 \times 1}{\cdot 00002764} = 141 \cdot 32$ standard units.

3. The number of units in an iron conductor, having a diameter $\cdot 0058$ inches, is to be found as follows :—

$$\frac{D^2 \times C \times R}{d^2} = \frac{(\cdot 0625)^2 \times 6 \cdot 45 \times 1}{(\cdot 0058)^2} = 749 \text{ units ;}$$

or so many miles of copper wire (No. 16 gauge) whose diameter is $\cdot 0625$ inches.

4. The number of ("Professor Wheatstone's") units contained in the standard unit referred to, is expressed by the following formula :—

$$\frac{D^2 \times 5280}{d^2 \times 1} = \frac{(\cdot 0625)^2 \times 5280}{(\cdot 071)^2} = \frac{\cdot 00390625 \times 5280}{\cdot 00541} = 4091 \cdot 5 \text{ units.}$$

Again, the standard unit referred to in the question is equal to 27 of "Siemen's" units. Therefore, "Siemen's" unit is equal to 151·54 of "Professor Wheatstone's" units, one of the latter being equal to $\cdot 0066$ of the former.

W. HALL.

Telegraph Works, Mansfield Street, Southwark, S.E.

To the Editor of THE ELECTRICIAN.

SIR,—Can you inform me if ever an induction coil has been constructed for producing *quantity effects* instead of intensity, as they are generally constructed? Would the power of the primary current be exalted to any great degree by using copper ribbon for the secondary wire instead of fine copper wire so as to produce heat and light?—Yours respectfully,

J. COOK.

[Induction coils for telegraphic purposes have been constructed to combine quantity with tension effects. A coil with closed magnetic circuit upon the principle adopted by Mr. T. Allan, appears to be well adapted for this purpose. Space would be economised by using the metallic ribbon ; but the turns of wire would not be at right angles to the core, and some amount of power would consequently be lost.—ED. E.]

INDIAN TELEGRAPH.

To the Editor of THE ELECTRICIAN.

SIR,—I am always pleased when I see any communication published that deserves special notice, and rejoice greatly at the very pertinent remarks contained in your correspondent M's letter, published in your last number.

And all those who feel interested will be able to form their own opinions as to whether the gentlemen connected with this great undertaking, have so far carried out fairly and without prejudice, the general requirements to ensure the success of this very important line.

There may yet be time before the members of the India Council are called upon to decide, to put themselves in possession of many facts to guide them in their deliberations, before venturing to rely entirely upon any reports supplied them, and among the many, I would suggest that reliable evidence should be obtained of the present state of the Red Sea cable, of the Malta and Alexandria cable, and of the 200 miles of gutta percha cable taken out by Mr. Latimer Clark, and never used.

The whole of this surely can be obtained from sources entirely free from being influenced by either the Gutta Percha Company or any firm advocating the use of india rubber ; this evidence would go very far in proving the danger of using gutta percha or any compound of gutta percha at all in tropical climates.

It would appear that Sir W. Brooke, the late Engineer to the India Board, from his own knowledge, entirely disapproved the use of gutta percha, because he no doubt knew the large amount of capital expended uselessly in attempting to send it out, and we are bound to assume from the many years of experience he had, that india rubber was far more likely to succeed, and the 20 miles now on its journey, will soon prove as to whether he was right or wrong.

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Very much might be said with regard to the engineers appointed by the Indian Government; their experience no doubt is very great with regard to gutta percha, but it is very questionable if they ever saw a mile of superior india rubber core, and if so are not at all prepared to adopt it; so that it will be invaluable to see published at some future time the tests employed which must prove the relative merits of gutta percha compound, gutta percha, also the compound of gutta percha and india rubber, and the various india rubber cores. It will be no great engineering feat to do this, as fortunately, the science of telegraphy is becoming wonderfully simplified, and facts will speak for themselves, regardless of the large amount of mystification hitherto employed, and the tests lately published by you, clearly show that the certainty of making any length of cable from pure india rubber is a fact beyond all dispute, and its durability is now only doubted by those who do not really require to know the fact that india rubber ,when properly manufactured, is very far superior to any gutta percha of the present date.—I am sir, yours truly, A. B.

To the Editor of THE ELECTRICIAN.

SIR,—As your pages are open to all matters connected with chemistry as well as electricity, I take this means of calling your attention, and the attention of your readers, to an invention which I became aware of, accidentally, the other day on my way from the City to the West End through Long Acre. I do not mention the shop at which I purchased it, as it may appear like an advertisement to increase, perhaps, the sale of a useless invention; but, "as good wine needs no bush," so this article has not yet been publicly advertised that I am aware of, although, it is one which I, and I am sure, the public generally must have daily felt the want of. I have some very beautiful steel work, which has occasioned me great trouble to preserve from rust, as servants are never very careful to look after articles belonging to their masters, which do not come daily before their eyes; and modern houses are so rapidly constructed, and the soil upon which our detached villas in the suburbs of this vast Metropolis are built is in some cases so badly drained, that it is a matter of the greatest difficulty to procure a new house that is to be called thoroughly free from damp; and, consequently our picture frames, and all our little fancy nicknacks, which in their original lustre, go so far to adorn a room, and give an air of elegance and comfort to our houses, are very frequently entirely destroyed, or deprived of their effect; and, indeed, at the close of the Exhibition, perhaps, no more forcible test could be practically applied to the riches and treasures of this world, than that preached by many of the beautiful trophies themselves, which seemed almost to say, "Lay not up for yourselves treasures upon earth, where moth and rust do corrupt."

This invention is called the "*ColourlessLacquer*," and, on the *lucus a non lucendo* principle, I suppose, it is only to be procured at a shop specially devoted to the sale of colours and drawing materials. It is a perfectly transparent and clear liquid, and is intended to be applied with a light brush to any burnished articles, which, if exposed even to the rain will not become rusty, or tarnished, for the space of more than three months. My wife is delighted with it also (as, we being frugal people, and not able to give very frequent dinner parties), she is able to preserve her best knives for festival occasions, without the usual anxiety to remove the chance spots, which even the heat of the hand in putting them away in their snug cloth-lined boxes, very frequently leaves upon them. I should think our maid, Betty, inwardly rejoices, as she has been the means of saving her young man a world of trouble; as, hitherto, he was to be seen every morning, most assiduously engaged in polishing his master's plate-glass shop-window-sashes, which now retain all their brazen brillancy, uncared for, save by an occasional application of this invention. If, by this letter, I have been able to alleviate the cares of any of your readers, I shall have pleasure in having subscribdd myself,

London, 25th Nov., 1862. "PATERFAMILIAS."

To the Editor of THE ELECTRICIAN.

INDIAN TELEGRAPH.

SIR,—Arrangements appear to have been made for the completion of the telegraph lines through a great part of India. The news is good, as regards the general extension of the telegraph, in those, to us, very important regions.

We may hope, that the gentlemen engaged, will take every advantage of the recent improvements in all parts of the manufacture, with the view of ensuring the success of this important undertaking.

The failure in almost all deep sea lines, renders very great caution necessary in the selection of the best description of cable; and it is much to be feared the decision may be too hastily given to ensure this.

We are all aware of the small proportion of submarine lines now in working order, so that the public, generally, cannot but wish, that every scientific and mechanical improvement will receive full consideration by those in whom the power of selection is vested.

Of the materials suited for insulation, more especially for hot climates, india rubber appears to be the best; so the majority of people think; but upon this, learned doctors differ, some avowing that gutta perch is useless in hot climates; others that there is not the slightest difficulty in this respect, so that to settle this point, the opinions of those thoroughly acquainted with the matter is required, with the view of giving the India Board the opportunity of receiving good value for the large sum to be expended.

The improvements lately made in scientifically using india rubber as the insulator, renders this article well worth due notice.

The testing of the cable, lately manufactured for the Indian Government, as published by you, appears fully to have established the high insulating properties of india rubber.

This fact considered, in connection with the knowledge that india rubber when properly applied is not affected by heat, is certain to call forth a desire to generally adopt it for this purpose.

The growing desire for extending the telegraphic system is really so great, that it is impossible to over value the importance of securing the best men for the work required; and next in importance is the proper system to carry it out. Trusting you will excuse these remarks,—I am &c.— A CITIZEN.

TELEGRAPHIC EXHIBITION.

To the Editor of THE ELECTRICIAN.

MR. EDITOR,—Your correspondent, Mr. Owen Rowland, suggests that a *soirée*, illustrative of telegraphic progress, should take place in London, in January, 1863. Although your correspondent *ought* to know something of the "ins and outs" of telegraphy, surely he cannot for a moment think that electricians, telegraph engineers, and manufacturers will ever unite to promote the establishment of "*An Institute of Electricians.*" Have they ever been united in anything? No sir, the establishment of such an "Institute" to them is not desirable.—Yours, &c., TELEGRAPHIST.

THE TELEGRAPH SOIREE.

To the Editor of THE ELECTRICIAN.

SIR,—Mr. Rowland's proposal deserves the most serious consideration on the part of us electricians and telegraphists generally. It has long been felt, that something ought to be done to bring us together in one way or another, and I think his proposal, that a soirée be held in London in the month of January 1863, is the best way of effecting that object. He may command my co-operation. I enclose you my card, and am &c.

P. Q.

To the Editor of THE ELECTRICIAN.

SIR,—Would it not be better for Mr. Rowland to have the Soirée held in March 1863, when all the members of Parliament are in town?

BELLA. P.

To the Editor of THE ELECTRICIAN.

SIR,—In the course of my miscellaneous reading, I came across the following, which struck me as likely to be interesting to your readers in the country during the approaching frosty weather. We have all experienced the exhilerating effects of a bright frosty day, when the wheels of our vehicle rattle upon the icebound road, and our favourite cob, who, perhaps, has been confined to the stable for a fortnight or three weeks, so far forgets his accustomed sobriety of demeanour, as to exhibit in the excess of his animal spirits, consequent upon an unusual amount of rest and an injudicious allowance of corn, a tendency to bolt away with us if he cannot succeed in putting his hind feet through the clash of the conveyance; or, in case we are bestriding his usually unimpeachable saddle, we sometimes feel ourselves like the original, portrayed by the skilful pencil of John Leach, in Punch, when Mr. Briggs realises the inconvenience of those playful equine proclivities, called "*buck jumping.*" As such sensations are likely to unsettle some equestrian nerves they will be glad, no doubt, to be put into possession of a means of effectually retaliating upon the nerves of their favourite but too excitable servant, and bringing him entirely under their control. Mr. Rarey succeeded in eliciting substantial marks of approval from the public, and, I make no doubt, but that the ELECTRICIAN will deserve equally well of those who are lovers of horses and horse exercise, if it places before its readers a means of attaining the same end by magneto-electricisim or electro-magnetism.

"To this end a pair of flexible conductors, formed of a single or triple copper, or silver wire, is inserted in the reins of the bridle, the forward extremities being each connected with a piece of moistened sponge, so attached to the checkbands, as to press, when in position, against each side of the horse's head at a short distance below the eye. The opposite extremities of these conductors, prolonged beyond the grasp of the reins, are fitted with rings or other suitable metallic attachment, so arranged as to be readily connected with the poles of an induction coil, set within the reach of the rider or driver, as the case may be."

I will try and procure additional particulars before your bucolic friends arrive from the country to visit the approaching cattle show, so that they may be able to witness the application of the invention at Islington. I am afraid that very few of the indigenous London horses have had sufficient rest during the late exhibition season, (even although they have the powerful protection of the Benevolent Society at no 12 in Pall Mall) to need any depressing influences, but I make no doubt, any of the London

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omnibus proprietors would make his fortune, if he could apply electricity in lieu of oats to half his cattle, up the Holborn Hill just about six o'clock in the evening.—I am, Sir, yours obediently.— PHILANTHROPOS.

London, 19 Novemher, 1862.

THE TELEGRAPH TO INDIA COMPANY.

To the Editor of THE ELECTRICIAN.

SIR,—It is well known that a "brilliant writer" accompanied the late expedition to the Red Sea. The description of Cleopatra's needle, Cairo, and the Pyramids, we have had. It would be highly entertaining to those concerned in the success of the science of submarine telegraphy to have a short account of the state of the submerged cable in that sea, and of the efforts made to recover it.—Your obedient servant, JUBAL.

[*Vide* the Report made to the Telegraph to India Company, Vol. II., p, 135.—ED. E.]

RED SEA TELEGRAPH COMPANY.

To the Editor of THE ELECTRICIAN.

SIR,—Can you, or any of your readers, inform me what has become of the 200 miles of cable sent to the Red Sea, with the view of repairing that unfortunate line? Has it ever been returned, and in what condition? Does the copper wire still maintain its position in the centre of the insulator? The information would, at the present time, be most acceptable to those interested (and who is not?) in the progress of ocean telegraphy.

L. M.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d.	per lb.
Negro	1s. 3d. to 1s. 4d.	
Java	1s. 6d. to 1s. 7d.	

GUTTA PERCHA

Nearly all the parcels have been purchased.

Fine	2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	„
Ordinary Reboiled	1s. 0d.	„

November 26, 1862. WM. KIRKMANN,

4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	———
20	Do. B 7 per cent. till 1862 .	—	———	———
Stock	Electric Telegraph . .	100	100 to 103	———
25	Do. New	20	———	———
5	London District Telegraph .	4¾	4 to 3 dis.	———
—	Lond. & S. Ireld. Direct Tel.	—	———	———
10	Mediterranean Extension Tel.	all	3 to 4	———
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	⅛ a ⅝
1	Do. registered . . .	all	⅜ to ⅝	———
10	Do. „ . . .	all	4 to 5	———
2	Telegraph to India . .	1	¾ to ½ dis.	———
5	United Kingdom Telegraph .	3	½ dis. to ½ pm.	———

Miscellanea.

VOLTAIC REDUCTION OF IRON.—Iron is reduced from its solution as protochloride, in the form of a lead grey deposit, which is very spongy if the battery power is strong. It is then a rather light powder, very soft and ductile.

HELP FOR LANCASHIRE.—At a meeting of the Mutual Improvement Society in connection with the Magnetic Telegraph Company's staff, held at the offices in Ducie Place, Manchester, it was resolved that each member would immediately subscribe half a day's pay to the relief fund, and further, that a fortnightly subscription of 2d. in the pound should be collected and handed over to Mr. M'Clure. An invitation is to be sent to every district superintendent, to render his assistance in promoting a similar movement throughout the whole of the service.—*Manchester Examiner.*

THE SYRA AND SCIO TELEGRAPH CABLE.—The following severe and satirical remarks are from the *Times* correspondent at Athens:—"By a strange perversity or a touching sympathy, the Austrian Lloyd of Trieste and the Messageries Impèriales of France, on whom we rely for our communications with the West, have chosen the same day in the week for their arrivals and departures, so that for six days in the week we know as little of what is passing west of Cape Matapan as if we were living in China. To make things worse, the submarine cable from Syra to Scio, which for a short time connected Greece with Constantinople and the rest of the world, broke down some time ago, and has not yet been repaired. Telegraphic messages are, therefore, likewise dependent on the French and Austrian mail steamers, which take them to Corfu, Messina, or Constantinople, to be forwarded thence westward. Owing to all these disadvantages—which are greviously felt, above all, at this moment—the Greeks were in almost total ignorance of the manner in which Europe had received the news of the late movement, the telegraph had, indeed, announced, in its usual vague and slovenly manner, that public opinion in England had expressed itself favourably; but this only increased the desire to know more, without removing altogether the uncertainty on so important a point. Situated as this country is, on the outskirts of Europe, and connected as it as been so long with the East by history, customs, and religion, one might suppose it naturally gravitated eastwards, especially after seeing it take part with Russia in 1854, and place itself in antagonism with the views of the West."

THE electricity developed during the passage of bodies from the solid or fluid to the gaseous state, was made the subject of a series of experiments, towards the conclusion of the last century, by La Place, Lavoisier, Volta, and Saussure. The bodies which were to be evaporated or dissolved were placed upon an insulating stand, and made to communicate, by a chain or wire, with a Volta's condenser. When sulphuric acid, diluted with three parts of water, was poured upon iron filings, inflammable air was disengaged with brisk effervescence, and at the end of a few minutes the condenser was so highly charged as to yield a strong spark of negative electricity. Similar results were obtained when charcoal was burnt on a chafing dish, or when fixed air or nitrous gas was generated from powdered chalk by means of sulphuric and nitrous acids. These experiments pointed to natural evaporation as the cause of the disturbance of the general electrical equilibrium of the globe, giving a surplus of positive electricity to the air, and leaving the earth surcharged with negative fluid. The subject engaged particularly the attention of Volta, who was at that time occupied in the investigation of the electric state of the air. In the course of his experiments, this distinguished philosopher had availed himself of the power of flame to attract electricity, and having found that when a taper was placed on the point of his conductor, his electrometer gave signs of a far larger quantity of electricity than when it was away, he suggested that the force of storms might be much mitigated by lighting enormous fires on elevated situations, the air being thereby robbed of its electricity. It does not appear that Volta ever carried this design into effect, though it was suggested by Arago that the conjecture might be tested in Staffordshire, and other English counties which abound in iron furnaces.

IT has been remarked that the Frauenhofer lines belonging to the air or to the gas through which the electric spark passes when working with an induction coil, are less distinct, and wider, in proportion as the strength of the electricity is increased; whereas, the lines belonging to metals, especially when somewhat refractory, like iron, remain perfectly sharp under these circumstances. The metal lines may also be distinguished, in some measure, in the solar spectrum, when examined with adequate magnifying power; with moderate power, certain lines appear somewhat prominent, and imbedded, as it were, in a mass of fine lines, which, upon the application of increased illumination, appear to withdraw themselves, and disappear, while the first-mentioned lines, on the contrary, only stand out in stronger relief. These are metal lines, and the most remarkable among them almost invariably belong to iron.

To Correspondents.

L. MADON.—Captin Selwyn R. N. has published his plan in the form of a pamphlet, which can be had of the publisher of this journal. The ELECTRICIAN circulates in Australia.

P. D. C.—Address Mr. Becker, Messrs. Elliott Brothers, Strand, London.

LIMARDI.—We shall be very happy to hear from you. The ELECTRICIAN has long since found its way to Italy.

JOHN R * * *. The core was manufactured by Messrs. Wells and Hall, of the Telegraph Works, Borough Road, Southwark. It is now, we believe, on its way to the Persian Gulf. It was constructed for the Indian Government.

MAGNETO.— Mr. W. T. Henley has constructed some very powerful magnets upon the principle you suggest.

SUPERINTENDENT.—See letters in present number. We shall endeavour to furnish you with the required information. Address to the publisher.

J. ELLIS.—Wishes to know who stabbed the Emden Cable? Can any of our readers enlighten him upon the subject?

W. H. MONNEY.—Your letter will be inserted next week.

O. R.—Too late for this week.

*** ELIAM.—The two volumes of the ELECTRICIAN are to be had bound. Address a note to the publisher.

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The Electrician.

VOL. III. No. 57.—DECEMBER 5, 1862.

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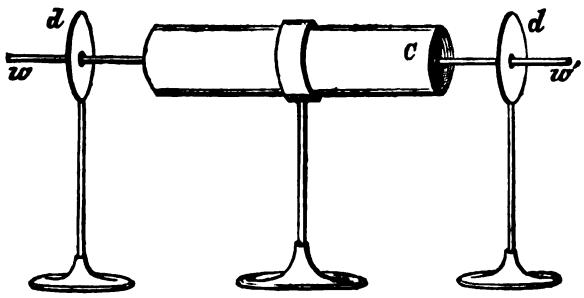
ON A METHOD OF SIGNALLING THROUGH SUBMARINE CONDUCTORS, BY MEANS OF CURRENTS OF INDUCED ELECTRICITY.

[Continued from p. 38.]

THE import of the observations and experiments given in our last number, will be rendered more obvious by the following additional experiment, in which the *conduction* and *induction* systems of signalling are brought into competition upon a miniature scale. Although the conditions of practice are by no means in every respect accurately reproduced, the data furnished by this experiment may nevertheless possess a certain practical value.

For our present purpose we may employ a gold-leaf electroscope, so constructed as to become discharged when deflected to a certain degree.*

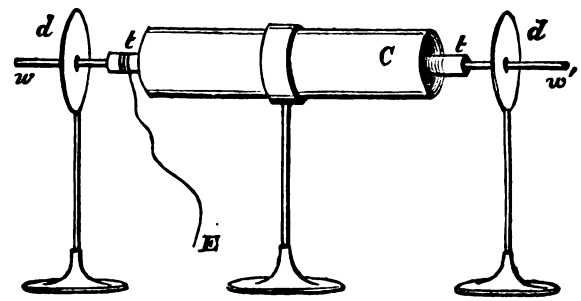
Fig. 1.



The discharge of the electroscope should be effected through a conductor offering great resistance, so that it may occupy an appreciable period of time. Or an ordinary gold leaf electroscope, the cap of which is connected to earth by a long cotton thread, may be made to answer the same purpose. The instrument is to be attached to w, fig. 1, and subsequently to E, fig. 2.

Let us now occupy ourselves with the transmission of signals through our miniature telegraph systems respectively. For our battery we may employ a DE LUC'S column, or a long strip of PULVERMACHER'S galvano-piline; in either case one pole is to be in connection with earth, while the insulated extremity is brought into contact with w' (fig. 1). The electroscope will immediately be deflected, but, owing to the resistance in the circuit, it will not instantaneously be discharged after the contact. Our object being to produce deflections as rapidly as possible, we may discharge the wire by contact with the finger at the transmitting station, and immediately charge it afresh by contact with the pole of the source. We shall find that for each *double contact*, with the pole of the source and to earth, a signal will be produced at the receiving station of our line—in which the electroscope, being better adapted to obtain an effect with the small quantities of electricity with which we have to deal, has been substituted experimentally for the galvanometer, or other signalling instrument. When the electroscope is transferred to E (fig. 2), we shall obtain a double rate of signalling with the same number of alternate contacts per minute; a signal being produced both when w' is connected to the pole of the source, and when it is connected to earth.

Fig. 2.



The intelligent telegraph manipulator may here observe, that if, instead of merely connecting w', in fig. 1, to earth, he brings it into contact with the opposite pole of the battery, the speed of signalling will then be the same in both cases. This is perfectly correct, but the fact is due to the imperfection of our apparatus as a representation of the conditions which prevail in a long submarine conductor. Supposing the wire to be charged with plus electricity in the first instance, we can obtain no signal by simply *discharging* the conductor, either to earth or by contact with the negative pole of the source. Its discharge, and a *fresh charge* from either pole are necessary before a second signal can be transmitted, and the period of time occupied in effecting these operations determines, in practice, the amount of retardation in the transmission of signals. On the other hand, under the conditions represented in fig. 2, it is clear that a signal is obtained both in charging and discharging the primary conductor $w\,w'$.

We may now proceed to examine somewhat more closely the various points involved in the problem now before us. Firstly, as to the construction of a cable adapted for signalling by means of currents of induced electricity. Insulation between the primary wire, represented by $w\,w'$, and the secondary conductor $t\,t$, may be obtained with a slight thickness of material; a low inductive resistance in the dielectric being unobjectionable, and probably advantageous. The inductive resistance between the secondary conductor and the external fluid, represented by the cylinder C, should, on the other hand, be considerable; as by the amount of this resistance will be determined the tension of the electricity liberated in this conductor, under the inductive influence of the charged primary wire. The sectional area necessary in the conductors respectively, and the mechanical construction of the enveloping secondary conductor, are points which may be reserved for future consideration.

We have seen that what is termed retardation of the current cannot properly be considered as due to the resistance offered by a conductor, since with the same conductor this effect may take place to a great, or to a practically imperceptible extent, according to the circumstances which modify the charging capacity of the wire. The resistance, as we know, affects the intensity of the current produced by a certain difference of tensions in the wire. It may safely be accepted as an axiom, that whenever a difference of tensions can be produced in a continuous conductor, a current or transfer of electricity must necessarily take place; the intensity of which will be proportionate to $\frac{E}{R}$, or the difference of tensions divided by the resistance in the circuit. The effect of conduction, whenever the difference of tensions has been established, may practically, in all cases, be regarded as instantaneous. In

* The single leaf electroscope of Dr. Robert Hare, is well adapted for this and similar experiments. The gold leaf is suspended in the centre of a globular or other shaped glass vessel, from a brass wire, surmounted with a brass cap. A similar rod of brass, carrying at each end a small disc of brass or gilt wood passes through the side of the vessel, so that the internal disc shall be immediately opposite the lower end of the suspended leaf. The wire slides freely through a socket, so that the internal disc may be adjusted at any required distance from the leaf. When the lateral wire is connected to earth, and the gold leaf charged, the most minute force of attraction is made apparent; and, if the charge be sufficient, the instrument becomes discharged by contact of the gold leaf with the interior disc in connection with earth.

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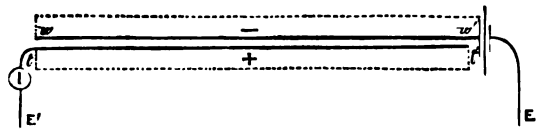
the conductive system of signalling, we fail to obtain a signal instantaneously, simply because we cannot instantaneously produce a sufficient difference of tensions in the conductor. The tension at the poles of the source falls to zero the moment contact is made between the wire and the battery, and is only partially restored when a supply of electricity has been furnished to effect the static charge of the wire. Providing, therefore, we can by any means establish instantaneously a difference of tensions in a conductor, we may obtain an instantaneous signal. And, if differences of tension, opposite in their signs, can instantaneously, or with great rapidity, be alternately established in this conductor, we may expect definitively to overcome the most serious practical objection to long lines of submarine wire, viz.: inductive retardation.

In the following diagram let *w w'* represent the primary conductor, and *t t'* the secondary conductor of a cable for signalling by currents of induced electricity. Contact being made at *w'* between the primary conductor and the negative pole of a source,

Fig. 3.



a current of induced electricity will traverse the conductor *t t'*, connected to earth at E', in the direction from E' to *t t'*; and the two conductors, constituting an insulated Leyden arrangement, will become charged, and will then be in the normal condition for signalling.

Let now a momentary contact be established between the extremity of the primary wire *w'* and the *positive* pole of the source. A portion of the *minus* electricity accumulated upon *w w'* will instantaneously be discharged, and an equivalent quantity of *plus* electricity upon *t t'* will as instantaneously be liberated at a tension directly proportionate to the quantity, and to the inductive resistance of the insulating dielectric surrounding this conductor, and inversely proportionate to the area of surface upon which it is distributed. A difference of tensions will therefore be established between *t'* and E', and a current of electricity will flow, in the direction from *t'*, to E', through the instrument at I.

Contact being re-established between *w'* and the *negative* pole of the source, a quantity of electricity sufficient, if passed through a galvanometer, powerfully to deflect the magnetic needle, will instantaneously be withdrawn from the primary conductor. The secondary conductor at *t'* will assume a condition of *minus* tension in regard to E'—the plus electricity being held inductively under the attractive influence of the *minus* primary wire; and a quantity of electricity equal to that withdrawn from the latter will traverse the secondary conductor in the direction from E' to *t'*.

Thus, the poles of the source being alternately connected to earth, and to the extremity of the primary conductor at *w'*, the reversals might be made to follow each other at any required degree of rapidity; the necessary conditions being a low inductive resistance in the dielectric between the primary and secondary wires, and a battery offering but small resistance, or capable of generating a large supply of electricity in an inappreciable period of time.

Thus much, at least, may be advanced from a theoretical point of view as worthy of practical verification or disproval, and as matter for the careful consideration of those who look for progress in telegraphic science. The study of the present problem may be fruitful in other systems, perhaps more perfect or more feasible than that which we have roughly indicated; and, although not so attractive as more pretentious and startling propositions have been, to those whose ideas relative to the possible applications of the electric agencies are vague and confused, it appears far more likely to lead to valuable and unlooked-for practical results.

DEEP SEA CABLES.

"Knowledge comes;" says the poet, "but wisdom lingers." We have long known—for it has been asserted upon good authority, and there has been sufficient opportunity to verify the fact—that iron-cased cables are essentially unfitted for laying in deep water. Within a few columns of each other, in this week's impression, will be found the opinion on this point given in May 1859, by Mr. Robert Stephenson, and that, expressed but yesterday, in opposition apparently to a powerful and inherent tendency to the use of an iron covering, by Mr. R. Hoskyn, R.N., lately commanding H.M.S. *Porcupine* in the expedition for obtaining deep-sea soundings to the westward of Ireland. Among the intermediate opinions upon the matter we can scarcely find one which is not strongly adverse to the iron sheathing for deep-sea cables.

It was probably in deference to this unanimity of expression that, while the fascinating but dangerous coils of wire were retained in the sample latterly put forward for adoption in a new Atlantic cable, costing £200 per nautical mile, their character was somewhat modified by a coating of gutta percha. The coil thus coated would by no means possess the same characters, chemical or physical, as the naked covering. It would closely approximate to a cable covered with a material, such as Mr. Duncan's ratan cane, of less specific gravity than iron or steel wire, or to a combination of iron and hemp saturated with an impervious compound. It is difficult to perceive what advantage, corresponding to its enormous cost, it would possess over either of these. If the number of fathoms of its own weight a cable will support in water is assumed as giving true data as to its mechanical perfection, it would be inferior to both. Indeed, it would from this point of view probably be inferior to any cable constructed, with the exception of those covered with naked iron, and therefore weighted above their strength. It is superfluous, consequently, to dwell upon the question of expense, as has sometimes been done, as though this were the only and unavoidable objection.

The advantages, and possible disadvantages, of combinations of iron, or steel, and hemp, and of other arrangements for securing strength and sufficient protection, among which that of Mr. Allan stands prominent, have often been referred to in our columns. The system of Mr. C. S. Duncan, however, has not hitherto received adequate notice. In this, it will be remembered, the ratan cane, growing spontaneously in inexhaustible quantities in many parts of South Asia, is employed for the outer covering. The cane may be obtained of uniform guage, in lengths of fifty feet and upwards, and a method has been devised for readily splicing it, so that the strength of the joints may be equal to that of the cane. There is sufficient evidence that it withstands, for a lengthened period of time, the action of water and the effects of hydraulic pressure. The following are some particulars which have been given relating to a cable covered with ratan only:—

Specific gravity	1·059
Weight per naut.	13 cwt.
Breaking strain	2¾ tons
Diameter	⅞ of an inch.

It will be seen that this cable fulfils, in an unusual degree, the requirements of Mr. Stephenson, of "a specific gravity but very little greater than that of water." A higher specific gravity might, however, be required, and in this case the cane would be combined with iron or steel wires in the spandril spaces. With a cable of this construction, and coated with a special compound for the protection of the steel wires, the following were the results of the mechanical tests:

Specific gravity	1·54
Weight per naut, ...	1 ton 7 cwt.
Breaking strain	6½ tons
Diameter	1 inch.

The suggestion of Mr. Duncan, of employing for telegraph

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cables a material which, in China and Japan, is universally used, twisted into cables and ropes, for shipping, &c., and which, under these circumstances, resists wear and tear, and the action of water, for a number of years, is well worthy of consideration; and the question of hemp and iron, *versus* the ratan, offers fair grounds both for discussion and comparative experimental examination.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY BY THE SUPPRESSION OF RETARDING INDUCTON.

BY RICHARD LAMING, M.R.C.S.

The application of the mathematical theory to electro-telegraphy has not placed the performance of the submerged cable upon an equality with that of the atmospheric wire, nor has it yet got data for doing so. What we want before all things is a *physical theory* of electricity, so comprehensive and precise, as to tell us, in unequivocal language, what improvements electro-telegraphy is susceptible of, and how we are to put out our hands to reach them. If Ohm had had a basis of that sort for his superstructure, he, probably, would have deemed half his labour superfluous; at all events, he would not have marred his work by confounding together, as he has done, under the same measurement, things that physically vary in different ratios; nor would others have thought it worth while to extend such calculations, only to exemplify what logicians well enough know, that exactitude built up upon inexactitude is both illusory and dangerous. *We need to be informed what that static electrical induction is which causes retardation, and how to suppress it.* Nothing short of that can satisfy the marine telegraphist. To control induction, when once established around a telegraphic conductor, and to make it useful, is perfectly hopeless. And if any one, distracted by the Babel of terms and explanations that pour in upon him in every direction, is in despair of ever falling upon a physical theory of electricity competent to keep his head clear, let him consider what chemistry was before Dalton threw out the idea of equivalent proportions, and also what astronomy was when Newton first conceived the unlimited operation of the universal attraction, let him reflect how simplicity and order in each of those instances suddenly emerged from complexity and confusion, so that what was at one moment thought unattainable, was, at the next, in our possession; and then let him say why electricity is to be a sealed volume any more than astronomy or chemistry. Who shall, *a priori*, assign a boundary to the consequences of even the smallest change in electrical doctrine? No one can be prepared to deny great results even to a simple limitation of the electrical attraction, in substitution for that indefinite affection between common matter and electricity which has been vaguely floating before our minds, under the similitude of "water and a sponge," ever since the time of Franklin. When we make a notable discovery in science, is it not the greatest wonder, not that it is found, but that a matter so seemingly conspicuous could have lain dormant so long? I venture to affirm it will be so with the true electrical theory after it is recognized; and the sooner we believe it attainable the better we shall act in the true spirit of philosophers, and have the benefit of it.

I wish to see mathematics used, and not abused, by electricians; and we do abuse geometry and numbers when we make them supersede either facts or the true conclusions of inductive reasoning, whenever calculation is traced into detail from unrealities; Poisson, Epinus, Coulomb, and Cavendish—all honoured mathematicians in the history of our science—taught us to calculate forces of electrical repulsion, but who has really ever believed in the physical existence of repulsion? It is a myth that has amused the schoolmen, but deluded the inductive philosopher, for it has thrown darkness rather than light upon the *modus operandi* of electricity, which we are all seeking to become acquainted with. As it has ever been in all cases of great improvement, so, doubtless, it will prove in the case of electricity—*the perfectioning of its theory will be marked by its simplification.* We were told to believe by Du Faye, in olden times, that there were two electricities; and by moderns, willing to escape from so glaring an improbability, we are taught to substitute for the electricities two electrical forces, and mystery upon mystery has been heaped together in their attempted elucidation; all which, I believe, is resolvable into a simple case of mechanical action and reaction. There is, perhaps, no one who has even carelessly pondered over the definite nature of electrical attraction, but has perceived that if the doctrine be true, common matter and its electricity must act in opposite directions, and with equal and reciprocally neutralizing forces; and, certainly, all who examine the doctrine profoundly will find that it abolishes a host of difficulties, while it creates none, and *that* is a characteristic one can hardly suppose distinctive of error.

It is not my purpose in this essay to enter further into electrical theory than the subject of electro-telegraphy demands; and, fortunately, the doctrines I shall have to bring forward will appear simple and intelligible, even to students not familiar with all the principles of mechanical philosophy; while, to the professional engineer, they will be interesting from the fact of their furnishing a design for both constructing and working the submarine cable, in a manner that promises considerable improvement upon the present practice. I may, therefore, have the attention of both classes of readers, and in that hope I shall proceed to my task, having thus, as briefly as possible, prepared the way for it.

(To be continued.)

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued).*

1793—Read, John.—

[A summary view of the Spontaneous Electricity of the earth and atmosphere, wherein the causes of Lightning and Thunder, as well as the constant electrification of the clouds and vapours suspended in the air are explained, with some new experiments and observations tending to illustrate the subject of Atmospherical Electricity, to which is subjoined the Atmospherico-Electrical Journal kept during two years, as presented to, and published by, the Royal Society of London. By John Read, of Knightsbridge, London. Printed for the Author, of whom it may be had; sold by Elmsley, Strand; Richardson, Royal Exchange; Hookham and Carpenter, Bond Street; Deighton, Holborn, 1793.]—8vo., plate.

1794—Walker, Ralph.—

[A Treatise on Magnetism, with a description and explanation of a Meridianal and Azemuth Compass for ascertaining the quantity of variation without any calculation whatever at any time of the day. Also improvements in compasses in general, with tables of variation for all Latitudes and Longitudes. By Ralph Walker, of Jamaica. London: Printed by R. Hendmarsh, Old Bailey, printer to his Royal Highness the Prince of Wales, 1794.)—8vo., 226 pages, with illustrations.

1794—Cavallo, Tiberius, F.R.S.—

[A complete Treatise on Electricity in theory and practice, with original experiments. By Tiberius Cavallo, F.R.S, In Three Volumes. Fourth Edition. Containing the Practice of Medical Electricity besides other Additions and Alterations. The third volume is entirely new, and contains the discoveries and improvements made since the Third Edition. London: Printed for C. Dilly, in the Poultry, MDCCXCV.]—8vo., plates.

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1794—MORGAN, G. C.—

[Lectures on Electricity. By G. C. Morgan, Norwich. Printed by F. March, and sold by J. Johnson, St. Paul's Church Yard, London, 1794.]—12mo., 2 vols., 247 and 477 pages, plates.

1794—CHURCHMAN, John.—

[The Magnetic Atlas, or Variation Charts of the whole Terraquious Globe, comprising a System of the whole Variation and Dip of the Needle, by which the Observations being truly made, the Longitude may be Ascertained. By John Churchman. London: Printed for the Author by Darton and Harvey, and sold by John Savell, Cornhill; Charles Dilly, Poultry; T. and J. Egerton, opposite the Admiralty; James Phillips, George Yard, Lombard Street, and Steel and Son, Tower Hill, MDCCXCIV., entered at Stationer's Hall.]—4to., 80 pages.

1796—GREGORY, G.—

[The Economy of Nature explained and illustrated on the Principles of Modern Philosophy. By G. Gregory, D.D., Joint Evening Preacher at the Foundling Hospital, author of essays, historical and moral, &c. In Three Volumes, with forty-six plates. London: Printed for J. Johnson, No. 72, St. Paul's Church Yard, 1796.]—8vo., 3 vols., containing 543, 589, 569 pages.

Contains: Vol. I., Book IV., of Electricity; Vol. III., Book IX., Chap. XXXV., Animal Electricity. This chapter is interesting, as it appears to have been written just *after* Galvani's experiment and discoveries, and *before* Volta had demonstrated their true origin.

1796—KIRWAN, Richard.—

[Thoughts on Magnetism. By Richard Kirwan, Esq., L.L.D., F.R.S., M.R.I.A. Dublin: George Bonham, 1796.]—Pam., 4to., 17 pages.

1796—KIRWAN, Richard.—

[Synoptical view of the State of the Weather in Dublin. By Richard Kirwan, Esq., L.L.D., F.R.S., and M.R.I.A. Dublin: George Bonham, 1796.]—Pam. 4to., (bound with the above.)

1798—WILKINSON, C. H.—

[An Essay on the Leyden phial, with a view of explaining this remarkable phenomenon, on pure mechanical principles, by which all the different appearances of electricity are more simply demonstrated, to which is added an Essay on Medical Electricity, physiologically investigating the nature of those complaints, where the influence of this fluid may prove beneficial. Illustrated with a variety of cases. By C. H. Wilkinson, Surgeon and Lecturer on Experimental Philosophy, at St. Bartholomew's Hospital. Loudon: printed and sold by Sampson Low, Berwick-street, Soho. Also sold by C. Law, Ave Maria Lane; Lee and Hurse, Paternoster Row; and of the author, No. 10, Leicester-street, Leicester Square, 1798.]—8vo. Illustrated, 220 pages.

1799—WALKER, A.—

[A system of Familiar Philosophy, in Twelves Lectures, being a course usually read by Mr. A. Walker. Containing the elements, and the practical uses to be drawn from the chemical properties of matter; the principles and application of mechanics; of hydrostatics; of hydraulics; of pneumatics; of magnetism; of electricity; of optics, and of astronomy. Including every material modern discovery and improvement to the present time. London: Printed for the Author, at his house, No. 42, Conduit Street, Hanover Square; G. Kearsley, Fleet Street, and Bell and Bradpate, Edinburgh, 1799.]—4to., Contains in Lecture II., On the Polarity of Matter, &c, from pages 41 to 64. Lecture VIII., from pages 323 to 391, On Electricity, plates.

1800—JONES, Rev. W.—

[Six Letters on Electricity. By the Rev. W. Jones M.A., F.R.S., late Rector of Parton. in Northamptonshire, and Minister of Nayland, in Suffolk. London: Printed for F. and C. Rivington, No. 62, St. Paul's Church Yard; at the anti-Jacobin Press, Peterborough Court, Fleet Street; by T. Crowder, Temple Lane, Whitefriars, 1800.]—8vo., Pam., 68 pages. The last letter dated Jan. 27, 1797.

1800—LORIMEC, John.—

[A concise Essay on Magnetism, with an Account of the declination and inclination of the Magnetic Needle, and an attempt to ascertain the cause of the variation thereof. Illustrated with copper plates. By John Lorimec, M.D., and Fellow of the Royal College of Physicians of Edinburgh. The Second Edition, with corrections. London: Printed by J. Dillon, Plough Court, Fetter Lane, for and sold by W. and S. Jones, opticians, opposite Leather Lane, Holborn, 1800.]—8vo., 53 pages, plates.

1800—CAVALLO, Tiberius.—

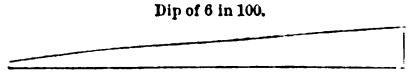
[A Treatise on Magnetism in theory and practice, with original experiments. By Tiberius Cavallo, F.R.S., &c. Illustrated with copper plates. The Third Edition, with a Supplement. London: Printed by J. Dillon, Plough Court, Fetter Lane, for and sold by W. and S. Jones, opticians, opposite Leather Lane, Holborn, 1800.]—Price 7s. in boards, 8vo., 335 pages, plates.

DEEP SEA CABLES.

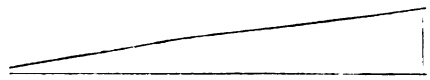
THE following communication relative to this subject, has been addressed to the Secretary of the Atlantic Telegraph Campany, by Mr. Hoskyn, R.N., whose Report "On the Deep Sea Soundings to the Westward of Ireland," has recently been given in our columns:—

DEAR SIR,—With reference to the conversation I had with you recently in Dublin on the subjects connected with my Deep Sea Sounding cruise in the *Porcupine*, I think that there can be no reasonable doubt now but that the descent from the Irish bank to the bed of the ocean is all that we can desire for the safe laying of the cable. So far from its being a precipice, a locomotive might run up some of the inclines, and many turnpike roads have steeper ascents, as the following diagrams more clearly illustrate, a dip of 6 ft. in 100 being the least, and 19 ft. in 100 the greatest we met with:—

Dip of 6 in 100.



Dip of 19 in 100.



The face of this slope—and indeed the bed of the ocean everywhere, when below the depth of 500 or 600 fathoms—is covered with the soft clayey substance called by seamen 'ouze.' This deposit, in the opinion of Professor King and other naturalists, is going on so copiously and unceasingly, that a cable once laid would, in the course of a few years, be 'covered up,' and so for ever sealed against the action of all external agencies.

The question, then, is, what kind of cable will be best adapted to these conditions of the bed of the ocean, and, at the same time, the cheapest and easiest laid across the Atlantic from Ireland to Newfoundland. And here I am sure that all seamen and practical men will agree with me that the lighter it is the better, so that it has but specific gravity enough to sink it.

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Much stress was formerly laid on the strain it would be subjected to from counter-currents, but our larger experience has taught us that these, like the precipice, are imaginary dangers, and that, in the part of the ocean the cable will cross, there are even no surface currents that will injuriously affect it—these appearing to be more of a surface drift, whose direction and strength depends on the prevailing wind.

That the cable should hold together during its descent through the still waters of the ocean does not require any great strength, probably the copper core alone would give it sufficient; but if, as we are told, a cable with a core of 5 cwt. of copper to the mile, coated with gutta percha, will have a breaking strain of 7 cwt., it surely is all that is necessary for its safe descent to the bottom.

A cod line, with a 90lb. weight attached for a sinker, occupies about 42 minutes in descending to a depth of 2,000 fathoms; and with a line of this description, made by Messrs. Newall, we have recovered a 64 lb. sinker from a depth of 1,750 ft.; this will probably give some idea of the opposing force the cable will meet in its descent to the bottom.

If not required for strength, of what use, then, is the iron wire? It will not prevent the attacks of minute animals, for in laying out it is always more or less strained and opened, and, moreover, these have never been found to attack gutta percha. Supposing the bottom of the ocean to be free from volcanic action, as it certainly appears to be between Ireland and Newfoundland, I know of no other force that would be likely to injure the cable. Careful soundings at intervals of 5 or 6 miles would teach us if any such danger existed, and how to avoid it. I think, therefore, that the lightest cable that can be made would be the one most likely to solve this problem successfully. The shore ends, and where it crosses shoal water must, of course, be protected. The comparatively small cost of such a cable, and the ease with which it may be run out, makes it worth a trial; if one should succeed, of which I have no doubt, we might soon have duplicates and triplicates.—I remain, &c.,

R. HOSKYN, Master, R.N.,
Late Commanding *Porcupine*.

Holywood, Belfast, Nov. 12, 1862.

THE TELEGRAPH AS AN AUXILIARY TO THE LONDON FIRE BRIGADE.

THE necessity of connecting the stations of the London Fire Brigade, with each other, and with the various quarters of the metropolis and the suburbs, is fully borne out by the lately published "Report on Fires in the Metropolis." It is a remarkable fact that, while Government protect life and property by an admirably organised police, it takes no precaution whatever to secure its subjects against being burnt in their beds. This duty devolves entirely on the insurance companies and a private association, the cost being defrayed by voluntary subscriptions. Fires, however, in London, are of daily occurrence. In 1861 not fewer than 1183 are enumerated; nor is this surprising, considering the vast extent of its builded area. According to the trustworthy evidence of Sir Richard Mayne, Commissioner of the Metropolitan Police, the area of the metropolitan police district includes 217 parishes, with a population of about 3,000,000, residing in about 462,000 houses; and the rateable income for taxation is about 13,500,00*l*. The extreme distance from the central point, indicated by Charing-cross, is a radius of 16 miles, and includes an area of about 700 square miles. This, however, is exclusive of the City of London, having a municipal jurisdiction of its own. It includes 97 parishes, with a population of about 115,000 inhabitants, inhabiting about 13,500 houses: and the rental for rating is about £1,337,000. Thus the whole of the metropolitan police area and of the City of London together, extending over some 700 square miles, may be considered as containing 3,115,000 persons, residing in 475,500 houses, while the rental for taxation may be computed at £14,800,000.

Previously to 1832 the several fire insurance offices of London kept brigades at their own individual expense, the engines being worked by Thames watermen, paid so much for each fire they attended, and they were known by the livery and badge they wore. In 1832 this separate system was consolidated, into what is now known as the "Brigade," the several offices uniting together and forming one common fund. The first cost was 8000*l*. a year, which has increased to 25,000*l*. At present there are 19 stations, and 127 men are employed. In connection with the brigade are some 50 horses and about 40 engines; included in the stations are the two floating on the Thames; so that on land there are eight double and nine single stations; the former of these have more than one engine, the latter only one. The services of the brigade are not confined to the metropolis; they have been sent to Dover, and there is no assigned limitation to their service. Their duties cease three days after a fire has been extinguished.

According to the evidence of Mr. Newmarch, secretary to the Globe Insurance Company, there is, within the radius of six miles round Charing-cross, insurable property to the value of £900,000,000, of which only £300,000,000, is insured, so that in one way or the other the charge of protecting the whole fall on one third. As the offices pay for the brigade they fix their stations where they please, and select the points where their pecuniary responsibility is greatest. Of course they choose those where insured property exists, and without regard to population and other property; and viewing the matter as they do, as one of pounds, shillings, and pence, they cannot be blamed for their preferences. On this point Sir Richard Mayne gave some important facts. Thus, the fire brigade station nearest to the House of Commons is in Chandos street, Covent garden, and there is only one in the whole line extending thence beyond the New Exhibition. There are none west of the parks towards Chelsea and Battersea. In Marylebone, Pancras, and Paddington, there is no station. As a rule the brigade looks after the wharves and the great mercantile establishments. Even were the means for preventing the spreading of conflagrations, far more adequate, the organised employment of the telegraph in a class of contingencies where time is most precious, and where the loss of a few minutes may occasion the sacrifice of human life, and of property to a vast amount, would appear a matter of the first necessity.

CHEMISTRY OF FOOD.

Abstract of a Paper read before the Society of Arts.

BY DR. LETHEBY.

[Continued from page 45.]

As a contrast to these, which may be regarded as dietaries, which just serve the purposes of ordinary existence, I may refer to the dietaries of hard working men. The troop of navigators which performed the task of making the railroad in the Crimea was daily supplied with 20 oz. of bread, 20 oz. of meat, 2 oz. of peas, 2 oz. of rice, 1¾ oz. of sugar, 1 oz. of coffee, and 4 oz. of rum per man. These, exclusive of the rum and coffee, contain 6·2 oz. of plastic matter, and 17·8 of respiratory; and the men used large quantities of food in addition, which they purchased on the spot. A navigator's weekly consumption, when at home, is 20 lb of bread, 6 lb of meat, 3 lb of potatoes, 12 oz. of cheese, 4 oz. of butter, 1 oz. of tea, 4 oz. of coffee, 8 oz. of cocoa, and 2½ gallons of beer, besides about 4 lb. of fresh vegetables, and sundry drachms of spirit; excluding the matter and 26·3 of respiratory. A Berwickshire reaper, according to Dr. Christison, consumes about the same amount of these materials; for his rations contain 7 oz. of plastic matter and 37·1 of respiratory. But the largest feeder of all is the Yorkshire labourer, who consumes daily about 8·8 oz. of nitrogenous beverages, these rations give a daily supply of 7·7 oz. of plastic food, and 42·2 of carboniferous. These ought to furnish the equivalent in labour of three million three hundred thousand pounds lifted one foot high.

In endeavouring to construct a table of nutritive equivalents for the carboniferous matter contained in different foods, attention must be paid, not merely to the relative proportions of fat, starch, and saccharine material, but also to the respiratory powers of these substances; for it is known that 10 parts of fat have the value of 24 of starch, or 25 of cane sugar, or 26 of fruit sugar, or 27 of spirit, or 77 of lean flesh; and experience shows us that these are the proportions in which they may be substituted for each other. A nation of hunters, and those who go naked and are exposed to great changes of temperature, consume large quantities of respiratory food; and if it so happens that the food is supplied in its least effective form, namely, as lean flesh, the quantity disposed of is enormous.

Liebeg asserts that if we were to go naked, like certain savage tribes, or if in hunting or fishing we were exposed to the same degree of cold as the Samoyedes, we should be able to consume half of a calf, and, perhaps, a dozen of tallow candles into the bargain daily, as warmly-clad travellers have related with astonishment of these people.

The amount of respiratory matter contained in food is quite as important for consideration as that of plastic; and in all our endeavours to give a practical tendency to the theoretical results of science, attention must be paid to the more solid facts of experience, for he who constructs a table of nutritive equivalents, without regard to all the constituents of food, that is, to the chemical composition of it in its totality, fails to give a practical value to his labours. Even in the case of the least important of all the nutritive components of food, namely, the saline elements, it is not a matter of small importance as to whether they are present in right proportion or not, for they are contained in all the tissues and fluids of the body, and serve the purpose of giving solidity to the structures, and of acting as means of conveying neutriment into the system, and of carrying the wasted materials out of it. They are, therefore, among the prime agents of alimentation and secretion. Of all these elements common salt is the most important.

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The other saline constituents of food are likewise of importance. Even the kind of salt contained in the water we drink may determine the kind of food that can be most economically appropriated.

These facts indicate the necessity for considering all the proximate constituents of food, and of giving to each its proper value in the theoretical construction of a dietary.

Again, it is of primary importance that the choice of a diet should not be dependent as much on the convenience of supply as on the requirements of the system. It is a remarkable fact, however, that these, in nature, are generally associated. Hence it is, that man in all parts of the globe finds in the produce of his own land ample and effective means of gratifying his wants.

Experience has shown that there are certain articles of food which are not particularly nourishing in themselves, but which serve some very important purposes in the animal economy. This is the case with tea and coffee; in fact, the use of a vegetable infusion, containing astringent matter and an active principle, rich in nitrogen, has been almost universal among mankind from the earliest times.

All Europe has chosen its prevailing beverage; Spain and Italy delight in chocolate; France, and Germany, and Sweden, and Turkey, in coffee; Russia, Holland, and England, in tea—whilst poor Ireland makes its warm drink of the husks of the cocoa, the refuse of the chocolate mills of Italy and Spain. All Asia feels the same want, and in different ways has long gratified it.

The physiological action of these beverages appears to be of a somewhat singular quality, for while they excite the brain, they calm the nervous system generally, and though they produce a state of wakefulness and activity, yet they also induce a species of languor and repose.

Another point of much importance in the economy of food is, that which relates to the preparation of it by cooking, &c. For the results of inquiry show that the processes of cooking and otherwise preparing alimentary substances have much to do with their digestibility and nutritive value. The experiments of Beaumont and others have proved that overdone meat takes a much longer time for digestion than that which is just sufficiently cooked; indeed, the real objects of cooking are to soften the intercellular matters of food, to set by coagulation the fluid albuminous constituents, and to develop flavours which the raw aliment does not possess. The temperature at which this may be effected is not very high; for a heat of from 150° to 160° of Fah. is sufficient not only to solidify the juices of flesh, but also to destroy their sanguineous appearance. In the process of cooking, therefore, the temperature should never exceed this point.

Again, the investigations of Liebeg demonstrate that the process of salting meat is very improper, for the brine extracts the juices of the flesh, and so removes most of the important constituents; in fact, salt junk and the hard beef of the navy have long been known as foods of very inferior value, and have been the cause of scurvy and other starvation diseases.

It is a matter of national importance how we can best preserve food without depriving it of its nutritive power, for by so doing we not only guard against the dangers of famine, but we also facilitate, even in times of plenty, the equal distribution of food.

In the preparation of the various flours or meals of grain, it is still a question, whether there is any advantage in removing the husk or bran. It is true, that it contains a very large percentage of nitrogenous matter, but the real question is, whether this matter is assimilable or not? Johnston, Liebig, and many others assert that it is, and they, therefore, recommend that whole meal should be used as food; indeed, the remarks of Liebig on this subject are very emphatic:—"The separation of the bran from the flour," he says, "is a matter of luxury only, and is injurious, rather than beneficial, as regards the nutritive power of the bread. In ancient times, down to the period of the Emperors, no bolted flower was known. In many parts of Germany, especially in Westphalia, the entire meal, including the bran, is baked into the brown bread called pumpernickel, and there is no country where the digestive organs of the population are in a better condition." On the other hand, Poggiale, who is a great authority on this subject, declares that the only use of bran is to retain food in the alimentary canal. Its composition shows that 39 per cent. of it are wholly unassimilable, and this he has proved by giving it to dogs, which lose weight by it. He has even found the bran unchanged in the matter discharged from their bodies; nay more, he has afterwards collected it and given it to other dogs, and then to fowls, so that it has passed through the systems of three animals successively, and yet it has remained unchanged. Still, however, it is an admitted fact, that a little bran in food favours assimilation, and, therefore, Poggiale recommends that about 4 per cent. of it should be retained.

Many ingenious contrivances have been suggested for increasing the nutritive power of wheat flour; one of these has received the attention of practical men. It is the invention of M. d'Arblay, and is a means whereby, in the process of grinding the flour, the meal may be separated so as to contain more or less than the average amount of gluten, and by the admixture of rivitts, or the hard wheat of Sicily, Russia, Sardinia, and Austria, the percentage of gluten may be greatly increased. Another means of improving the alimentary value of wheat is, by mixing it with rich soup or extract of meat. This constitutes the patent process of Mr. Borden, whose biscuits contain about 32 per cent. of flesh-forming matter; in fact, a pound of biscuit contains the extract of five pounds of meat mixed with half a pound of flour.

Other modes of increasing the nutritive power of vegetables are founded on the removal of their less valuable respiratory compounds.

In this country many thousands of cwts. of flour are annually used in the manufacture of starch, and, as the process is usually followed, all the rich gluten is lost; but by a contrivance originated, I believe, by Mr. Orlando Jones, and practised by Durand and others, the gluten is extracted from the flour by an alkali, and is then precipitated in an edible form, so that it can be mixed with flour and made into bread. This, in the economy of food alone, is a valuable application of science.

I regret that I have not time to discuss the question of the relative digestibility of different foods, for this, in an economical point of view, is clearly of the greatest importance.

A last point for consideration is the effect of over or under feeding on the animal system. Too much respiratory food favours the development of fat, and often checks the proper nutrition of the muscular tissues; hence it is that rice feeders and potato eaters, and those who indulge in fermented liquors, are often bloated in their appearance, and are not capable of prolonged exertion. The brewers' drayman is a bad subject for the ward of an hospital, for though he usually has all the appearance of a man possessed of great muscular strength and vital endurance, yet it is not so in reality, for the muscular tissues have been encroached upon by fat, and the general power has been weakened by an undue influence of the respiratory element. Most of the animals in our menageries, from a too liberal allowance of respiratory food, die from fatty degeneration. When the plastic constituents of food are in excess, the system becomes excited, as if from the development of force, and a savage disposition is often the consequence. A nation of animal feeders is always a nation of hunters, for the use of a rich nitrogenous diet demands an expenditure of power, and a large amount of physical exertion. Accumulation of the nitrogenous elements in the blood is often a prolific source of disease; in fact, very recently, attention has been drawn to the diseases of overfed convicts.

An interesting discussion followed the reading of the paper, but we have only space for the remarks of Sir Charles Fox, who said that through the means of these researches they might be able to arrive at the point when they could say, if they gave a man so much food, they might get a certain amount of work out of him. The present greatness of England depended upon the industry and labour of the people, and also from the fact that this country possessed a greater amount of machinery than any other. The brains and energies of Englishmen had been devoted to the improvement of machinery, but they had thought very little of the best mode of feeding a man to get the most labour of him. It has been his lot to employ a great amount of labour in different parts of the world—in Spain, France, various parts of Germany and Scandinavia—and he had found that he never got so much labour out of any men as out of English workmen. On making inquiries with regard to the diets of different nations, he had come to the conclusion that this did not arise from superior talents on the part of the Englishman, but from the fact that, in France and Germany, the workman was not so well fed as in England. Although skilled labour fetched a higher price in London than in any other part of the world, yet the employer of labour found that nowhere could he expend his capital so profitably. It was a great moral question to see the human family well fed and well prepared to perform the important duties allotted to the human race.

In our volume for 1859, page 43, there is an interesting account, by Mr. D. G. Fitz-Gerald, on the application of the hygroscopic properties of chloride of calcium to the drying of buildings, linen, tobacco, &c. In the western Annexe of the Internation Exhibition, we noticed that the surfaces of Krupp's samples of steel, broken by the hammer, and kept under glass cases, were in a singularly bright and untarnished state. On examination we found that this was owing to the presence of chloride of calcium; a saucer containing some of this deliquescent salt being placed in every glass case.—*Mechanic's Magazine.*

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Applied Chemistry.

MANUFACTURE OF THE PRUSSIATE OF POTASH.

THE most extraordinary event in the history of this manufacture is, the attempt made a few years ago to introduce the air process, which is of much interest both in a scientific and practical point of view. As cyanogen is rapidly converted into ammonia, the artificial formation of the former from the nitrogen of the air would likewise furnish an unlimited supply of ammonia, of which, the importance to agriculture could not be over estimated. The experiment was pursued with singular perseverance and ability, as will appear from the following valuable details given by Mr. F. R. Hughes, of Borrowstowness :—

"In 1844, we commenced a series of experiments upon the large scale, at Newcastle, in company with Messrs. Bramwell, to manufacture prussiate of potash, without annimal matter, substituting the nitrogen of the atmosphere for it, and continued the experiments till the latter end of 1847.

"In these operations, a tube or retort of fire-clay was placed in a vertical position in a furnace, so constructed that, when the formation of the carbonic oxide was prevented, sufficient heat could be obtained to soften a Stourbridge fire-brick throughout its substance, when exposed on the flue, or off-go, to the full force of the fire.

"The lower part of the retort was made of cast iron, kept out of the vicinity of the fire, and of sufficient length to afford time for the mass heated by the fire to become cool before it was discharged into a cistern placed below containing water and a proto-salt of iron, into which the lower end of the tube dipped. Provision was made at this end of the tube to regulate the periodical discharge of its contents, in whatever proportion was desired.

"The tube was filled with charcoal, saturated with a solution of the carbonate of potash of commerce, and dried. The mixture in this state generally contained 20 per cent. of potassa (KO).

"By means of an air-pump, the atmospheric air was drawn through the tube of alkalized charcoal, in a continuous stream from the top, and discharged below in the state of nitrogen and carbonic oxide.

"The alkalized charcoal was thus found to become pretty rich in cyanide of potassium, one half of the alkali of the cyanized charcoal has frequently been found, on testing, to be in cyanogen, so that when all was working well, 36 to 41 cwt. of prussiate of potash were produced in a week, by means of 7 or 8 retorts, of 10 to 12 feet long, in the fire, and two feet internal diameter.

"In our first experiment much narrower tubes were employed, to which the heat was applied only externally; but as both the tubes and charcoal are bad conductors of heat, we could not operate upon sufficient quantities, and we found it necessary to build larger tubes with fire-bricks, of the above dimensions, leaving a circle of small apertures or chinks in the tube, every third or fourth tier of bricks, through which the intensely heated gases, nitrogen and carbonic acid, were drawn from the flue surrounding the tubes, by the action of an aspirator. We thus had the mass in the interior of the large tubes, so hot that an iron rod, one inch in diameter, became white hot, when thrust down in the centre and allowed to remain there five or ten minutes.

Our next improvement was to use alkalized charcoal undried, and to aspirate the air from below, upwards, instead of downwards, the surplus heat drying the alkalized charcoal before it reached that part of the retort in which the cyanide was produced, a length of six to eight feet. The top of the retort was in this case, rendered air-tight, and the cyanized mass discharged below, as before.

Through seven or eight retorts of the above size, about 2,400 cubic feet of alkalized charcoal were passed in a week, and about 1,200 to 1,400 cubic feet of cyanized charcoal were obtained, nearly one half of the charcoal being consumed.

There were two great drawbacks to the process; one, the immense quantity of material to be lixiviated for a small return of prussiate, the other, and by far the most important, an extraordinary waste of potash in this process, upwards of three parts by weight being consumed in producing one of prussiate. The whole of this waste could never be properly accounted far. About one part, of course was recovered in a state of prussiate. It was found that another was lost in the small refuse charcoal, which could not be lixiviated to pay, and the remainder appeared to be partly combined with the bricks of the retort, and partly dissipated up the chimney.

In 1847 we abandoned the experiment, after a loss of many thousand pounds. But we proved the possibility of producing large quantities of cyanide of potassium, by drawing intensely heated nitrogen and carbonic acid gases, through a mixture of potash and charcoal, with the difficulty of carrying this out as a manufacturing process from the great waste of potash.

Our experiments were more directed to making the air process practicable, for the purpose of manufacture, than to ascertain upon what principle the formation of cyanogen depended, for it was immaterial in a manufacturing point of view, whether the cyanogen were produced from the nitrogen of the atmosphere, or from the ammonia the charcoal was always found to contain. The means of nicely observing the changes, were lost, from the necessity which existed in operating upon large masses, to draw the intensely heated gases from the fire into the body of the tube, in order to bring the alkalised charcoal to a proper heat for the production of cyanide of potassium. Is it probable that some part at least, of the cyanogen was furnished from the ammonia in the charcoal, which in separate experiments in the laboratory, was found not to be entirely given off at a red heat. Some alkalized charcoal, also brought to a proper heat in a porcelain tube, produced a considerable quantity of cyanide of potassium, without the presence of air, the ends being stopped up. On the other hand, when the retorts were filled with charcoal, *not alkalized*, and the heated gases drawn through, no formation of either cyanogen or hydrocyanide of ammonia, could be detected.

I have only further to mention, that we substituted soda for potash, in the process, with the like loss.

Mr. Bramwell also considers that the process succeeded perfectly, in a chemical point of view, although it did not answer as a commercial speculation, and ascribes its failure in economy, chiefly to the circumstance that the fire-clay tube could not be made to resist long the combined action of the alkali and of the excessive heat applied.

LIGHTNING CONDUCTORS.

ACCORDING to a correspondent of "Cosmos," each of the two columns of Antonine and Trajan at Rome, sustains a collossal bronze statue, and the columns, not being in a state of conduction with the earth, are in danger of being injured by lightning. In fact, accidents have already happened, but as yet without causing any great damage. The preservation of these monuments is a matter of interest to the whole civilised world, on account of their historical value. Their precarious state is such that Napoleon III. has lately had a complete model of the column of Trajan made for his own use in writing the biography of Cæsar. Professor Volpicelli, in 1848, proposed to protect these structures by means of a conductor, arranged like the one on the Duke of York's column. From various reasons, political and otherwise, this has not been done.

Some persons have urged that the best plan would be to use a number of lightning conductors placed on the surrounding buildings. It has, however, been show that this indirect protection is worse than useless, being, in fact, absolutely dangerous. Professor Mossotti has, on this subject, thus expressed himself in a recent paper on lightning conductors :—"If, instead of placing a lightning conductor *directly* on to the column, you place a series of conductors on to the neighbouring houses, any given flash of lightning, instead of being deviated from its course, will be directed towards the column you wish to protect. The surrounding air, being in a low state of polarization by the action of the conductors, will absolutely prevent the lightning from taking a side direction." These observations are, of course, just as applicable to tall factory chimneys as to classical columns.

While upon this subject, we will give some extracts from a paper on Lightning Conductors, lately read to the Academy of Sciences of Paris by M. Calland. He states that lightning conductors are being made in France of thin brass wires. As is well known, the coefficient of conduction of this alloy is 12, that of iron 16, and that of copper being 100. Metals also get heated by the electric fluid in an inverse ratio to their respective powers of conduction. The chains of suspension bridges have been broken in this way. If brass be not so liable as iron to combustion, it is more fusible; and a conductor made of this material might get fused by a violent electric shock.

M. Calland states that he makes his cables of seven strands of copper wire, there being seven wires to each strand; this number permits of the wires being twisted together with fewer intermediate spaces. He also states that the humid conductor of the ground is usually not made equal in conducting power to the one of metal. The custom is to untwist the end of the cable, and to place it into some water. The conductor having a sectional area of one square centimetre, its conducting power will be represented by 91,440,000; that of silver being 100,000,000. The relative conducting power of distilled water being only 0·0133, a moist surface of 700 square metres would be necessary in order to reach the conducting powers of the cable. In case of a violent shock, such a small surface as this would

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almost form an insulation. M. Calland proposes to place the end of the rod touching the ground in animal charcoal, and to surround the latter with a quantity of coke. These two substances are excellent conductors of electricity, and the porous nature of coke renders it admirably fitted to increase the surface of contact of the conductor.—*Mechanic's Magazine.*

THE TERCHLORIDE OF NITROGEN.

This formidable compound is usually obtained by inverting a jar of chlorine in a leaden vessel, containing a solution of sal-ammoniac at the temperature of 90°. The gas is absorbed, and an oily substance is formed at the surface of the fluid, and falls to the bottom of the vessel. This is the terchloride of nitrogen NCl_3, the most dangerously explosive substance with which the chemist is acquainted. Indeed, the above method of producing it is by no means free from danger. The jar containing the chlorine should not be touched whilst the operation is continued, unless the face and hands be protected; a slight agitation being often sufficient to resolve the compound into its elements, with a force sufficient to shatter to pieces vessels of cast iron. With suitable precautions, however, it may be collected at the bottom of the leaden vessel in which it is formed. A small quantity may safely be exploded by touching it with the extremity of a long cane, moistened with oil or turpentine. The lead is indented, but not shattered, by the explosion. Most organic substances containing hydrogen effect its decomposition.

By means of the voltaic battery, small quantities of the terchloride of nitrogen may readily be obtained, and the general character of the compound ascertained without danger. Four elements of Bunsen's battery may be employed for this purpose. A stout wire or strip of platinum, should be attached to the positive terminal. Upon passing the current through a concentrated solution of the chloride of ammonium (sal-ammoniac) hydrogen is evolved at the negative electrode, and the chloride of nitrogen appears in the form of oily drops at the positive platinum pole. By bringing the two poles into contact, the compound is decomposed, with a more or less violent explosion, according to the quantity collected.

The terrific violence with which the explosion of a few drops of the terchloride takes place, appears to be due to the fact that one of the products of its decomposition is gaseous nitrogen, an element which cannot be condensed into a fluid at any degree of pressure that has hitherto been applied. The unstable nature of the compound, even when hermetically enclosed in leaden vessels, appears to preclude the possibility of utilizing the force thus generated, for the purpose of blasting rocks, &c., except it be by a system in which the electrical agency is employed for the generation and subsequent explosion of the compound at a distance. An apparatus for this purpose has been contrived by the writer; the action of which may be readily understood. In the bottom of a conical vessel of glass, terminating in a tube of some length, is fixed, as the positive electrode, a stout wire of platina, in proximity to which, and capable of being adjusted to any required distance from the bottom of the tube, is a wire of iron, constituting the negative electrode. The vessel, which should be of considerable capacity, is filled with the solution of chloride of ammonium; and the poles of a battery are attached respectively to the platinum and iron electrodes. The apparatus being left for a certain period, the chloride of nitrogen accumulates at the bottom of the tube around the platinum wire; and ultimately a sufficient quantity of the compound is generated to cause it to come into contact with the iron electrode, when explosion immediately takes place. The glass tube, in which the terchloride accumulates as it is formed, may be inserted in a cavity drilled in the rock.

Law Intelligence.

JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

Wednesday.

BAKEWELL'S PATENT PROLONGATION.—ELECTRIC TELEGRAPHS.

Mr. Macgregor was counsel for the petitioner; the Attorney General and Mr. Welsby watched the case on behalf of the Crown.

It appeared from the opening statement of the learned counsel that this was the petition of Mr. Frederick Collier Bakewell for the prolongation of the patent granted him in December, 1848, for improvements in electric telegraphs. Under the present system the correctness of a message depended on the correctness of the clerk, but Mr. Bakewell's invention obviated that disadvantage. By a chemical agency the message, as written by the sender, was received in fac-simile. The process was that the sender wrote on tinfoil covered with varnish which was removed in writing, and at the other end a perfect fac-simile was produced. By the patentee's system and no other a drawing or plan, or even a portrait or patterns of silk could be reproduced by telegraph; messages could also be sent in cypher, and even totally undiscernible, for the paper on which the message was received would appear perfectly clear from marks until it had been placed by the person to whom it was addressed in a chemical solution. Messages had been successfully sent as experiments between London and Brighton, and on 600 miles of French railways, and the invention had been much praised by the officials of the electric telegraph companies, but they had declined to adopt it as it would entail expense in its substitution for the existig system. Mr. Macgregor then read some of the best authorities in favour of the invention.

Lord Chelmsford said that the learned counsel, he supposed, only used that to show that Mr. Bakewell had made his invention known and if that were so, and it had not been used, that was rather against its utility.

Mr. Macgregor said the patentee, in seeking for a prolongation, relied on the extension of lines, and then his invention would become a necessity. Up to the present time, as it had not been used, the patentee had received no benefit, but on the contrary, had been at a loss of from £200. to £300.

The formal proofs having been put in, the petitioner proved the case as stated by counsel.

The Attorney-General said that no doubt the invention was very ingenious and beautiful, and the inventor had reaped no benefit, but it would be dangerous to grant a prolongation of a patent where no user had been proved. With that remark he would leave the case in their lordships' hands.

Lord Chelmsford in delivering judgement, said their lordships had, on more than one occasion, intimated that they would not advise a prolongation where there had been no user, which was always a presumption of inutility, which, however, it was competent to meet by rebutting evidence, which, if satisfactory, would be an answer to the presumption. This invention was very beautiful and reflected the highest credit on Mr. Bakewell; but as he had made it known and it had not been used, he could only speculate that it would be adopted if their lordships granted a prolongation. Therefore, while admitting the great merit and beauty of the invention, their lordships, acting on a reasonable principle, could not recommend the prolongation of the patent.

Application refused.

The Student.

THERMO-ELECTRICITY (*continued.*)

A most important application of thermo-electricity was made conjointly by M.M. Nobili and Melloni, in the construction of a thermopile for the measurement of minute degrees of heat. The couple adopted was of antimony and bismuth. Thirty or fifty small bars of each metal were soldered alternately at their extremities, and arranged as a prismatic bundle in a manner that will be understood from the following description. Fig. 1, represents one of the layers of which the pile, Fig. 2, is composed. The dark-shaded portions, *a*, are the bars of antimony, and the portions more lightly shaded, *b*, those of bismuth.

Fig. 1.

Lateral contact between the bars is prevented by means of silk or paper; and pieces of the same material are placed between each layer of which the prism in Fig. 2 is formed. Here, it will be seen, the layers are arranged vertically. In the first series, of five or more couples, a bar of antimony is at the top; in the second a bar of bismuth.

The lower bismuth of the first series is united by solder to the lower antimony of the second series, *et seriatim;* so that if the elements of the pile were placed in a straight line, each bar of bismuth would be

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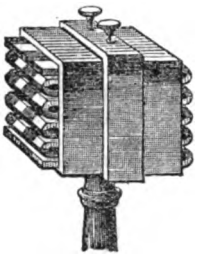
soldered at each end to a bar of antimony, and *vice versâ*, with the exception of a terminal bar of bismuth, and one of antimony.

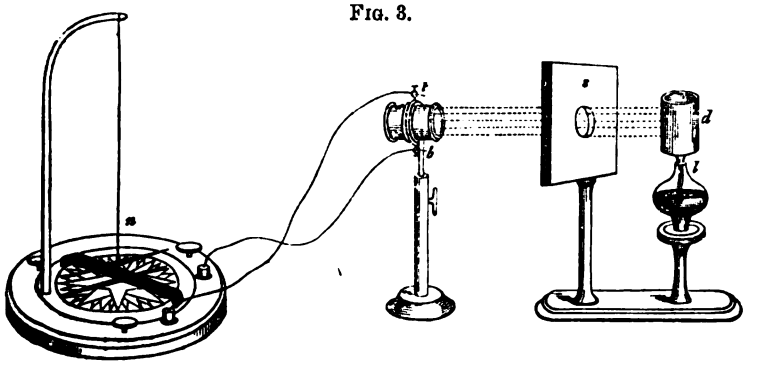
To each of these terminals may be attached a copper wire insulated with silk, and connected with binding screws upon the brass frame in which the pile is contained. The inner surface of this frame must

FIG. 2.



be covered with some insulating material. The two terminal faces of the pile, exposing the alternate surfaces of junction, should be covered with lamp-black, a substance with absorbs, instead of reflecting, the rays of heat. The apparatus is completed by suitably mounting the frame and adapting to it two brass caps which cover the terminal faces of the pile. In Fig. 3, is shown this thermo-electric pile as arranged by Melloni for his experiments on radiant heat; *t* and *b*, being the binding screws connected with the extreme antimony and bismuth bars; *n*, the galvanometer with the astatic needle; *l*, a lamp heating the copper cylinder *d*, and *s*, a perforated screen through which the radiated heat falls upon one of the faces of the pile, from which the brass cap has been removed.

FIG. 3.



The delicacy of this apparatus is such that, according to Melloni, it is capable of measuring a difference of temperature of $\frac{1}{2250}$ of a degree centigrade.

In all thermo-electric arrangements the current ceases when one of the surfaces has obtained the maximum degree of heat from a given source, or when the difference of temperature between the two surfaces remains constant. A current in the opposite direction is generated when the heated surface is allowed to cool.

The apparatus above described is that which is most valuable to the physicist. The more massive combinations, though capable of producing a current of greater power through a circuit of small resistance, are not generally susceptible of being used as a useful and delicate thermoscope.

The use of solder in thermo-electric combinations is somewhat objectionable, as the effect produced is dependent, in a great degree, upon the nature of the fusible compound employed. In the thermo-couple of Pouillet, described last week, this objection may be avoided by adopting the excellent method of construction recommended by M. J. Regnault. Instead of the fragile bars of bismuth, tubes of glass, filled with the melted metal by aspiration, are employed. These tubes are generally bent into the form of an elongated U; and copper wires are attached to each extremity by inserting them in the metal at these extremities when fused by the heat of a spirit lamp. Instead of using a number of vessels filled alternately with melting ice and boiling water, for the purport of exciting a series of these couples, we may simply bend the wires so that the alternate junctions may be together, in which case two vessels, one filled with heated sand, and the other with oil of turpentine, or other non-conducting fluid, in contact with a freezing mixture, will suffice for any number of couples.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d.	per lb.
Negro	1s. 3d. to 1s. 4d.	
Java	1s. 6d. to 1s. 7d.	

GUTTA PERCHA.

Nearly all the parcels have been purchased.

Fine	2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	„
Ordinary Reboiled	1s. 0d.	„

December 3, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	54 to 57	——
20	Do. B 7 per cent. till 1862 .	—	——	——
Stock	Electric Telegraph . .	100	100 to 103	101½
25	Do. New		——	——
5	London District Telegraph .	4¾	4 to 3 dis.	——
4	Lond. & S. Ireld. Direct Tel.	—	——	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered . . .	all	⅜ to ½	——
10	Do. „ . . .	all	4 to 5	——
2	Telegraph to India . .	1	¾ to ½ dis.	——
5	United Kingdom Telegraph .	3	½ dis. to ½ pm.	——

MR. ROBERT STEPHENSON ON THE CONSTRUCTION OF A TELEGRAPH CABLE FOR LAYING IN DEEP WATER.

24, *Great George Street, May* 25, 1859.

DEAR SIR,—I regret my inability to give you so confident or satisfactory an opinion as I should desire on the questions submitted to me respecting suhmarine telegraphs for deep seas: the most I can do is to furnish you with such deductions as can be drawn from our present limited experience, premising that nothing of the magnitude contemplated has yet been successful carried out.

As to the form of the conductor, this will evidently be a continuous circular copper medium, composed, either of a strand of small wires, or of segments composing a large wire.

It would be imprudent to use a single wire on account of the evident risk arising from a weak place at a joint or elsewhere: no practical advantage as regards conducting properties exists in a single rod, beyond the fact that it is the most condensed form in which the requisite conducting area can be obtained. The copper must be of great purity, or at least possess great conducting power, as there is considerable variation in this respect with different samples.

With respect to the area of the conducting wire, one fact is well established, that, within all practical limits, the larger this area is the greater will be the advantage, both as regards inductive retardation, and the non-liability to damage from the diminished battery power requisite.

Submarine lines have been generally constructed of No. 16 copper wire (·065 inch diameter), weighing about 60 lbs. to the mile. In the Atlantic cable the weight was 95 lbs. to the mile. In the Amsterdam cable the weight is about 120 lbs. to the mile. The Red Sea conductor is, I believe, still heavier. In all cases, except that of the Atlantic cable, batteries of moderate intensity have been sufficient; but in this exceptional case, the small area in propertion to the length, rendered it necessary to use currents of such high intensity as to incur serious risk of damaging the insulating medium, whereas in the Amsterdam cable a battery of thirty-six cells is found sufficient. Assuming this to be the limit of intensity in your case, the conducting wire would require to weigh no less than 300 lbs. per mile. This may probably be considered excessive, but the error would be in the right direction; certainly nothing lighter than 200 lbs. per mile can prudently be recommended.

With a conducting wire weighing 300 lbs. per mile there will be

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every probability of ensuring a practical speed of from fifteen to eighteen words per minute.

With a conductor weighing 200 lbs. per mile the speed will probably come up to ten or twelve words per minute, which may be considered sufficient.

With respect to the insulating medium, the choice is practically limited to two materials—gutta percha or caoutchouc. It is true that with respect to caoutchouc but little experience can be quoted as regards its durability, or its mechanical properties when applied to submarine work; of its insulating properties there can be no doubt, and a method of manufacture lately introduced has obviated the difficulties originally experienced in using it as an insulating material.

I should have no hesitation whatever in using it if circumstances should render it advisable.

As regards gutta percha, it is almost unnecessary to observe, that as an insulator it has practically proved to be all that can be required: and as far as our experience goes (which extends over eight or nine years), it appears to be imperishable in water; at least it has never been found in the slightest degree deteriorated under such circumstances.

Both these substances have the disadvantage of being extremely liable to mechanical injury; and gutta percha is, in addition, peculiarly subject to damage from exposure to high temperatures.

The thickness of the covering material is limited by the cost: the minimum would be a thickness of certainly not less than $\frac{1}{8}$th of an inch, in three separate coatings of gutta percha. I should have much preferred a thickness of $\frac{3}{16}$ths of an inch, the diameter of the insulating wire being altogether a little over half an inch.

In coating with gutta percha, great advantage is obtained by the use of Chatterton's patent composition between each of the coatings, which is the process adopted by the Gutta Percha Company.

I must, however, remark that these opinions are expressed on the consideration that the cable should be constructed of the very best description, with a view to great permanency, as a good working cable may evidently be made at a much less cost in every respect. In this I have taken into account the effects of retardation from induction, and have confined myself to practical suggestions.

Lastly, we come to the outer covering, about which more diversity of opinion exists than with respect to the core. Iron wire has been so generally applied, that some remarks are necessary in advocating a departure from usual practice. However advisable, and indeed indispensable, iron may be for shallow waters, it is certainly not well adapted to great depths, and indeed quite inapplicable to such a depth as that contemplated. In fact, a wire-rope of such a length will do little more than support its own weight, and its strength is, therefore, evidently insufficient to meet the accidental strains to which it must necessarily be subjected. Iron is also a material which is liable to rapid destruction in sea-water from rust, and steel is liable to a similar objection, although quite admissible as regards strength. When either of these materials is employed, it should be inclosed with hemp, which not only protects to some extent from rust, but, if properly combined, assists materially in increasing the strength. I am, however, of opinion that neither of these is well adapted for a deep-sea cable, and have no hesitation, under proper precautions, in recommending a hemp covering in preference.

In the only experiment I am aware of, in which a hemp covering was employed, viz., the cable laid down from the North of Ireland to the English coast, the result was a failure. The circumstances were, however, entirely different, and such a result might have been expected. We, however, have undoubtedly this serious difficulty to contend with, that there is no practical experience as to the behaviour of hemp under such circumstances.

The outer covering material may undoubtedly be made an important element in the efficiency of the cable: for this purpose hemp is peculiarly adapted, as it is capable of being so used as to become an important non-conducting medium between the water and the core; but it remains to be proved that hemp will bear the necessary wear and tear unavoidable in the shipping, handling, and submerging of the cable; and secondly, that it will form an efficient and durable protection when laid down.

I can imagine no reason why hemp should not fully meet all the requirements of the case as regards protection when the cable is laid down, provided the depth is so great as totally to insure you against ocean currents, or destruction by animals or other marine organizations; and provided always that the bottom of the ocean be moderately level, and not rocky. In great depths I apprehend that the bottom of the ocean will certainly be free from any dangers on this score, if no under-currents exists, and this will, I presume, be ascertained. As regards the cable, therefore, when laid down in deep water free from under-currents, I am of opinion that a hemp-covered cable will be efficient, nor would the destruction of the hemp be a serious evil, though I think it would prove as durable as the gutta percha itself.

With respect to the efficiency of hemp as a protection for so delicate a material as gutta percha during the process of manufacturing, shipping, and laying down the cable, I must confess I have some fear as to the result, unless the covering be of a different character from anything I have yet seen; I see, however, no difficulty in devising a cable free from all such risk.

Some experiments would be necessary in arriving at such a result, and the object in view should be to obtain a covering possessing great strength and stiffness, and resembling, as near as possible in elasticity, lightness, toughness, and strength, the catgut-covering of an ordinary whip handle. This can only be obtained by saturating the fibres of hemp, in a vacuum and under pressure, in some suitable gum, insoluble in water, such as mastic or copal; the gum should be elastic, and not plastic; therefore pitch, or ordinary marine glue, would not answer the purpose. In fact, a perfect cable for a deep sea should be of a specific gravity but very little greater than that of water, so that it could be paid out with the same ease as a common log line: while its covering should be a non-conducting medium, whose strength and durability should be as great as possible, and not formed of twisted material, likely to shrink, nor of soft and flabby materials liable to entanglement.

Such a cable would entirely obviate the great strain to which all heavy deep-sea cables must be subjected in laying them out—a strain which has so often proved fatal, and is, indeed, the great source of all the difficulties of the subject. The breaks would become simple light machines, easily managed; and the speed of paying out might, in such a case, be much increased.

It will, however, be evidently necessary to make special arrangements for shallow water, where an iron cable must be used, of great weight, and composed of large wires, further protected by a coating of hemp and pitch.

I have thought it more useful to give a somewhat positive opinion on the matters subjected to me, without detailing the theory or the arguments by which these results are arrived at; I must again, however draw attention to the very imperfect state of all theory on the subject, and strongly urge the necessity of making careful experiments before a cable of such great value and importance can with prudence be put definitely in hand.—I am, &c.

(Signed) Robert Stephenson.

Sir S. Northcote, &c.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—As I have had considerable experience in the construction of the induction coil, *à la Ruhmkorff*, and have made what I consider to be one or two improvements in the same, I forward, for insertion in your journal, should you think proper, the following descriptions of the arrrangement that I have found to give the best results, and by which all the ordinary phenomena of static electricity may be exhibited in the most satisfactory manner:—

The Iron Core.

In constructing the core I first form 4½ pounds of No. 22 iron wire into a bundle, of the following dimensions:—Total length, 17 inches, diameter, 1⅝ inches. This bundle is then to be tightly bound together by means of silk thread, and capped in the ordinary way, at both ends, with iron discs.

I prefer varnishing the bundle of wire, before binding it, which may very readily be accomplished by pouring a quantity of quick drying varnish in at one end of the bundle, and allowing it to soak through to the other end. When the iron core, thus formed, is quite dry, it may be capped with two or three thicknesses of leaf gutta percha, to insulate it from the primary coil.

The Primary Coil

Which gives the best results when in connection with the battery, hereafter to be described, consists of 300 feet of No. 14 cotton-covered copper wire (weight 3 pounds) wound in four layers into a coil 8 inches long.

This coil should be tightly bound with silk thread and varnished. When the bundle of iron wires, forming the core, is introduced into this coil it will be found that the bundle projects 4½ inches on either side of it, for I find that, by thus making the core at least twice as long as the coil, *its efficacy is greatly increased.*

The Secondary Coil.

The reel for the secondary coil should be thus constructed:—

First, form, by means of glue and cartridge paper, a tube 13 inches long

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and a little over 2½ inches in diameter, just sufficient to admit of the introduction of the primary coil. To each end of this tube attach a disc of gutta percha, or mahogany lined with gutta percha, having a diameter of about 7 inches. The tube is then to be surrounded with five or six cappings of leaf gutta percha, upon which is to be wound (as evenly as cotton on a reel) a layer of silk-covered wire, No. 35.

This layer or coil should be 8 inches in length, which will leave a space of 2½ inches on either side, between the layer and the disc of the coil. When this layer is completed it must be capped with *six* sheets of leaf gutta percha, upon which another similar layer of secondary wire is to be bound, which, in its turn, must also be capped with six sheets of gutta percha, and so on up to 20 layers, after which, seven sheets of gutta percha should be employed for insulating instead of six.

These layers are to be continued until they amount to 36 in all. The secondary wire will then be a little over three miles in length.

The Condenser.

Which may be conveniently packed in a box or tray placed under the base of the machine, should consist of at least 80 sheets of tin foil, 20×10, each sheet separated from its neighbour by means of 3 sheets of cartridge paper. I find that plain cartridge paper is very nearly as effectual as varnished paper.

These sheets of tin foil must be alternately connected, 15 connected together on one side, and 15 on the other.

The two ends thus obtained are to be attached, in the usual manner, to either side of *make* and *break*.

When a slight separation is made in the secondary circuit, in a manner presently to be described, a coil thus constructed will give a spark in air from three to four inches in length, when excited with 12 Smee's batteries (immersed plates 7×3½) and will exhibit a beautiful band of light in a glass tube exhausted of air through a space of upwards of six feet.

In the box containing the condenser, I generally place a small glass plate coated on both sides with tin foil, one side of which I connect, by means of an *insulated* wire, to a brass collar made to slide on a glass rod supporting one end of secondary coil, and the other side I connect to the other end. See diagram, O and C′.

By this arrangement, the coated plate can be included in the circuit of the secondary wire, whenever required, by simply sliding of the brass collar C′. The well-known astonishing change is effected in the character of the spark; instead of the usual thready appearance, we now obtain a dazzling flame upwards of two inches in length, attended with a continuous roar, truly surprising.*

To obtain a constant stream of electricity flowing in one direction, such as will deflect permanently the needle of a galvanometer, all that is necessary is to form a *slight separation* in the secondary wire: this may also be accomplished by means of a sliding brass collar on an insulating glass rod.

Independent of the interesting philosophical speculations involved in the study of voltic-electric-induction, the induction coil will, doubtless, eventually be found susceptible of practical applications of the greatest importance. Already, it has been successfully employed for working the telegraph, and I may mention that I myself have constructed coils of such potency, that an energetic deflection of the needle of a galvanometer could be obtained by means of them. It will be found, when the coil is excited, that the needle of the galvanometer will not stir: the moment, however, we form a separation on the secondary circuit, by sliding down the brass collar about a quarter of an inch, the needle of the galvanometer will be deflected, and will continue so as long as the current is passing.

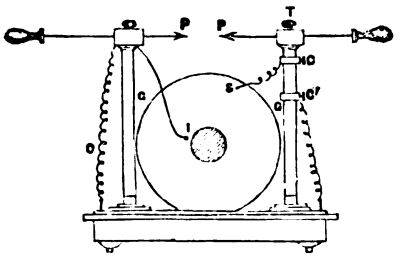
As the current in the secondary wire, derived from making the connection of the primary coil and battery, is of less intensity than that obtained from breaking the connection, it is highly probable that the former current does not possess sufficient tension to overcome the resistance offered by the separation thus formed; but not so the latter, consequently we obtain a current flowing in one direction only.

If a *very* slight separation be made by means of the sliding collar, it will be found that a much longer spark can be obtained in air between the points, than when wire is not thus divided, the cause of which I have, as yet, been unable to discover.

No philosophical instrument with which we are acquainted, so forcibly illustrates the reciprocal dependence and mutual convertibility of the imponderable agents—heat, light, magnetism, chemical action, and electricity—as the induction coil.

For we here have chemical action converted into, or setting in motion, electricity; electricity inducing magnetism, magnetism reproducing electricity, and from electricity we obtain either heat, light, magnetism, or chemical action. Indeed, it is now a very generally received opinion, that these physical forces are identical in their nature, constituting, instead of separate primary powers, a single power of a higher order of simplicity.

Here is represented an end view of the coil. P P are the points between which the spark from the secondary coil passes. S is the outside, or tension end of coil, and I is the inside end. C C′ are the sliding brass collars on the glass rod G. The upper one is for forming the separation in the secondary line, as here represented, and the lower one is in connection with the coated glass plate hidden in the base of the machine. If, now, we bring the upper collar in absolute contact with the brass top, T, and a galvanometer be included in the circuit of the secondary wire,



between points P P, although the galvanometer was upwards of 160 miles distant, and the battery employed in connection with the coil was excited with *pure water* only.

W. H. MONNEY.

Dublin, 1862.

* It will be found a great improvement to thus connect a coated plate, when sending the current through tubes exhausted of air.

To the Editor of THE ELECTRICIAN.

SIR,—Could you oblige by informing me, through your columns, at your earliest convenience, how, and where the condenser for increasing the size of the spark is applied to Ruhmkorff's galvanic induction coil? and by so doing you will oblige, yours truly,

W. O. H.

Fenchurch Street, Nov. 28th, 1862.

[*Vide* pp. 184 and 189, No. 16, Vol. I. The condenser is attached to the separate pieces of the contact breaker, so that when contact is broken the induced electricity in the primary wire may flow to the conductor, which allows of its accumulation in a static form.—ED. E.]

Telegraphic News.

AT an extraordinary general meeting of the proprietors of the Electric and International Telegraph Company, held on the 2nd inst., a resolution enabling the directors to convert or consolidate 7199 new shares, issued under the resolution passed at the extraordinary general meeting of 8th October, 1857, now existing in the capital of the Company, in respect whereof the whole money subscribed has been paid up, into general capital stock, to be added to the general capital stock of the Company, and to be divided among the shareholders according to their respective interests therein. The chairman stated that every exertion was being made previous to May next, when they would be prepared with new wires on all the great lines of communication in Scotland and the north, and in the manufacturing districts and the large seaports. As to the means by which it was proposed to carry these additions into effect, the board proposed to issue 15,000 shares—not giving any to the public, but retaining them exclusively among the proprietors, every one being entitled to participate according to the amount of company's stock he might hold. Upon which they would ask a deposit of £1 10s. each, and these shares would be registered as £3 paid up, being a bonus of 15 per cent.

AN extraordinary meeting of the Atlantic Telegraphic Company is convened for the 12th December, to consider "a proposition for the issue of £600,000, new capital in preferential shares, of £5 each, bearing 8 per cent. interest, guaranteed, in case of success, by the British government; any further profits to be appropriated, in the first instance, to paying a dividend of 4 per cent. on the old capital, and beyond that amount to an equal division between the old and new shareholders, and the formation of a reserve fund."

FAILURE OF THE TOULON AND ALGIERS SUBMARINE CABLE.

Le Temps of Tuesday lasts, states that the "Brandon" steamer was suddenly despatched from Toulon to Port Vendres, on the 20th ult. in consequence of the breaking down of the Toulon and Algiers Submarine Telegraph Cable.

TELEGRAPHIC FEAT.—A New York paper states that on the 13th ult. a telegraphic despatch was sent from New York to San Francisco between four and five in the afternoon, and the answer was received between six and seven, long before the hour had arrived at San Francisco at which the original message was sent from New York. The distance is about 3,500 miles, considerably exceeding the distance from Newfoundland to Valencia, and, says the New York paper, greater than any circuit ever yet worked in the history of telegraphy.

THE following is from the *Calcutta Englishman* of the 22nd of October:—

The rains are now decidedly breaking off, and were any proof of this wanting, it is afforded by the fact, that within the last two days we have been in direct communication with Bombay by electric telegraph, the distance being by the route followed—viz., from Calcutta to Agra and thence to Bombay—1,550 miles, no intermediate office receiving the

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message. There can be no further doubt, then, with regard to the outturn of the crops, which are stated to be very good from all quarters connected with our port.

TELEGRAPHIC COMMUNICATION BETWEEN INDIA, AUSTRALIA, AND CHINA.

In 1860 Mr. F. Gisborne, as the representative of forty banks and firms trading with India and Australia, offered the colonies of the latter, to connect them telegraphically with India and China, for a guaranteed subsidy of £35,000 a year. This was to be done by means of cables from Singeepad to Rangoon, *via* Moulmein, King Island, and Penang; to Canton, *via* Larawack, Labrian, Manilla, and Laigon; to Brisbane, *via* Java. Owing to the failure of the Java cable, and the necessity for a new one, the subsidy, asked for, was increased to £50,000 a year. This scheme is still under consideratioa by the colonies, but owing to the recent explorations of the Australian continent, a coast telegraph line, from Java to Queensland, appears to be viewed with disfavour, and a land line from Brisbane to Port Essengton, or from Adelaide to North Australia, is spoken of as perfectly practicable and more economical.

Miscellanea.

Cast-iron Magnets.—In the Exhibition of 1851, Mr. J. N. Hearder exhibited a cast-iron permanent magnet, consisting of 24 plates 2 inches wide, and 0·19 inches thick, cast in the form of a horse-shoe, 16·75 inches in length. The 24 plates were strongly fastened together, and the poles, which were at a distance from each other of 1·25 inches, were capped with soft iron, for the purpose of concentrating the magnetic power, while at the same time it renders the grinding of the poles unnecessary. The economy of construction, as compared with a steel magnet of the same dimensions, is estimated as 4 to 1. Mr. Hearder observed that whatever might be the relative powers of the plates previously to their being put together, they are subsequently found to undergo a considerable change; the two external magnets having their poles slightly reversed, the two next being neutral, and the rest, having direct polarity, being strongest in the centre, and gradually diminishing towards the two external plates. On testing the individual power of each of the magnets, after their combination during three years, the sum of the whole was less than 15 lb., whilst collectively they were capable of lifting a weight of more than 100 lb.

Professor Botto's System of Telegraphic Transmission.—In this system the signals depend upon the number of voltaic couples employed to deflect the distant needle. This is ascertained at the receiving station by placing in the circuit pair after pair of plates in opposition to those at the transmitting station, until the needle returns to zero, when the number of cells thus employed gives the letter or signal. The system, though ingenious and original, is not altogether adapted to the requirements of practice.

Burdett's Domestic Telegraph.—This apparatus was designed to supersede the use of a number of bells in mansions, club-houses, hotels, and public buildings. It is composed of a dial, around which are inscribed the numbers corresponding to each room of the house, of an index capable of pointing to any of these numbers, when the wire from the corresponding room is pulled, and of a single bell. By this means the confusion arising from a number of bells is avoided. A similar apparatus, worked by electricity, has been exhibited by Mr. Reid.

Phillip's Fire-Annihilators.—The fire-annihilator is a portable machine, for the immediate production of steam and carbonic acid gas, in an atmosphere of which the most vivid combustion becomes speedily extinguished. It is formed externally of a cylindrical vessel of iron from 16 by 8 inches to 24 by 12 inches, which is charged with a composition of powdered charcoal, nitrate of potash, and gypsum, in the following proportions: powdered charcoal 20, nitrate of potash 60, gypsum 5. The materials are boiled together in water, and afterwards dried in a stove, at the temperature of 100° Fah.; they are then moulded into the form of a brick, in the axis of which is a cavity for the reception of a bottle containing a mixture of chlorate of potash and sugar, with which, when the bottle is broken, a few drops of sulphuric acid are allowed to come into contact. The charge is placed in an inner cylindrical vessel, perforated with holes, which is itself within another vessel also perforated, for the passage of the gases; both these vessels are contained within a double cylindrical receiver, the lower part of which contains a quantity of water. The apparatus is closed by two covers, with openings, for the escape of the vapour. In the centre of the outer cover is placed a spike, for the purpose of breaking the glass bottle deposited in the cavity of the charge. The spike, upon being forced down, breaks this bottle, and the sulphuric acid, falling upon the chlorate mixture, causes instantaneous combustion, which is communicated to the charge, causing the evolution of an immense volume of vapour, the generation of which continues until the whole of the water is converted into steam, and the charge entirely consumed.

Chemitypy.—For the purpose of obtaining casts with *raised* lines from an ordinary engraving, the process of chemitypy, though involving considerable labour, is very effective. A polished plate of zinc is covered with an etching ground; the design is etched with a point, and bitten in with dilute nitric acid; the etching ground is then removed, and every particle of the acid carefully removed. The plate is then covered with filings of fusible metal, and heated by means of a spirit lamp, or other convenient means, until the fusible metal has filled in the lines of the engraving. When cold, the fusible metal is removed by suitable mechanical means from the surface of the zinc, with the exception of those portions which have entered into the lines of the engraving. The plate is then submitted to the action of very dilute hydrochloric acid; and as, of the two metals, the fusible metal is negative to the zinc, the latter is alone attached, the fusible metal which had entered into the hollows of of the engraving being left in relief. The plate may then be printed from by means of the typographic press.

Amorphous Phosphorus.—The red amorphous, or allotropic, modification of phosphorus, which, but a few years ago, was merely a curiosity in chemical laboratories, is now manufactured, according to a method suggested by Schrötter, in large quantities, and has become an important article of commerce. It is perfectly innocuous when handled, and, unlike ordinary phosphorus, does not give off fumes when exposed to the atmosphere; whilst it is better adapted to the manufacture of lucifer matches than ordinary phosphorus. The latter becomes converted into this substance when exposed, out of contact with air, to a temperature of 482° to 500° Fahr.

Irridescent Films.—Mr. De la Rue obtained in 1851 a prize medal for various applications of irridescent films to purposes of decoration; the vivid colours being produced merely by the agency of light upon a thin transparent film of varnish. The process is as follows: The articles to be ornamented are immersed in a vessel of water, upon the surface of which, when perfectly tranquil, is dropped a little oil or spirit varnish, which, spreading in all directions, becomes extremely attenuated, and reflects the most vivid colours of the spectrum. The varnish being fixed, the object, which is slowly raised, so that the film may adhere to its surface, is allowed to dry, when the varnish is found to adhere without any loss of its original brilliancy of colouring.

Mr. G. F. Guy, of Bury St. Edmunds, has constructed a large electro-magnetic engine, of considerable motive power, which was exhibited at the recent meeting of the British Association at Cambridge, and which, he states, can be worked profitably.

We again hear of electro-motive machines, one by an inventor at Bury St. Edmunds, the other by M. Bonelli, the well known mechanician, to whom the electric telegraph in Italy owes much of its efficiency. The solving of the electro-motive problem has been so often announced, that we must wait for further proofs before believing that a machine has really been constructed which will draw a load. It appears, however, that M. Bonelli has succeeded in making a working model, which has been tried at Manchester with promising results. By a peculiar combination of coils, and soft bars, excited by a Grove's battery, he causes the machine to run swiftly along a line of rails. A foreign journal in commenting on this experiment, remarks, that an application of the apparatus in an underground tube, would furnish the means for very rapid conveyance of letters. *Chamber's Journal.*

The Thermogenerator.—A machine is being tried at Marseilles, called the "thermogenerator," in which the heat to be used in distilling is obtained by means of the friction of two surfaces. The steam and boiling water required are thus obtained without the direct use of fuel.

Mr. Gisborne, late commissioner for Newfoundland in the International Exhibition, having obtained a patent for the invention of a system of ship's steering signals, has received instructions from the Board of Admiralty, to fit the apparatus in Her Majesty's ship "Rhadamanthus," at Woolwich. The apparatus consists of a couple of boxes, placed respectively on the bridge, and in front of the helmsman, which are connected by means of a strong electric cable. On the face of each box are four metal flaps, under which are painted the words "port," "starboard," &c. These are worked by the simple touch of a knob or handle attached to the box, and the orders are replied to in a similar manner, without the slightest risk or danger of the order being misunderstood, as at present, by means of the voice. Master Commander Sturdee, and the officers of the "Rhadamanthus," as well as several naval men of experience, who have visited the ship since her return to Woolwich, and have seen the instrument, all speak of the invention with approbation.

To Correspondents.

W. & T. H.—The stereotyped articles in which the supposed improvements are periodically referred to, must be taken *cum grano*. We cannot reproduce them even for comment, as the statements are entirely one-sided, and more or less inaccurate.

G. T.—A *mètre* is 39·37 inches, a *decimètre* 3·9 inches, a *centimètre* 0·39 inches, and a *millimètre* 0·039 inches.

H. Walters.—We will make inquiry, and inform you at an early date.

All Communications for the Editor to be addressed to 32, Paternoster Row, EC.

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The Electrician.

VOL. III. No. 58.—DECEMBER 12, 1862.

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THE PERSIAN GULF CABLE.

IN another portion of our columns is reproduced a document detailing the conditions under which is to be granted the contract for sheathing eight hundred and seventy-five miles of wire for this important line. From this we learn, that gutta percha insulation has been definitely decided upon by Colonel STEWART, R.E., who has succeeded Sir W. BROOKE in the Direction of Telegraphs under the India Office. It is well known that the predilections of Sir W. BROOKE were strongly in favour of caoutchouc insulation, as being best adapted for shipment to a warm climate, besides being possessed of advantages less essential in such a case. Indeed, the sample length of twenty miles of cable, insulated with caoutchouc, which has been referred to in our columns under the present heading, was considered so satisfactory by the authorities then at the India Office, that the adoption of a similar mode of construction in a cable of greater length was regarded as almost inevitable. We can afford no explanation of the reasons which have influenced the India Board in arriving at their present decision; nor are we altogether certain that any reason, which would bear the test of publicity and practical examination, could be given. In a matter of such moment, however, some explanation is certainly due,—not alone to manufacturers, who, for many years past have devoted themselves to perfecting the insulation in cables for tropical climates,—but to all who are interested in the extension of our telegraphic systems. The present case is only one of the instances in which it is both inexpedient and unjustifiable to ignore the necessity for some degree of publicity in questions of practical science. If there be grounds, as may possibly be the case, for believing that gutta percha, when properly and carefully applied to submarine wires, is adapted for shipment to Arabia, the absence of any necessity for further endeavour and improvement in insulation with caoutchouc, should at least be intelligibly signified, if not satisfactorily explained, to those whose efforts have been given in this direction, or who may be otherwise interested in the question. In either case, failure—where failure has been the rule rather than the exception—would become more comprehensible.

That our present observations are not uncalled for will be seen from the following brief details of the proceedings of the India Board in the matter of this cable. Early in the present year, several manufacturers of telegraph cables were invited to forward sample lengths of wire, from which a selection might be made for the line in contemplation. The result of this competitive measure was that an india-rubber covered wire was chosen, and an order given, with commendable caution, for some twenty miles of core, which was submitted to further examination. At page 306 of our second volume we give some account of the testing of this wire, at the Gutta Percha Works, *in vacuo* and under pressure. It was understood, and there was sufficient reason to believe, that this short length of cable for the Persian Gulf was not only satisfactory, but more than realized the expectations of the India Board. Within a short period, however, the same manufacturers were, somewhat vexatiously, called upon to prepare fresh specimen lengths of wire, for the purpose of being tested. Of the result of the tests, in this instance, we know nothing; and we can only vaguely surmise that they may have been unfavourable to the material which had previously been adopted for insulation. If this conclusion be not accepted, we can only share the mystification of those of our readers whose anticipations have been disappointed. Among these, some may have been put to needless trouble and expense; but we have little to do with private interests, and if the Persian Gulf cable proves a success, we may congratulate them upon indirectly contributing to this result. If, in fact, the second edition of samples had not been supplied, we might still be under the mistaken impression that the less plastic material would have proved most suitable for our Indian system of telegraphs. If not for such destination it is difficult to perceive where india-rubber covered wires could, with advantage, be employed.

In regard to the sheathing of the core, we perceive that the old system of spiral iron wires is to be adopted. These, however, will be carefully, and probably efficiently, protected from the effects of corrosion. To secure greater strength, the wires are specified to be hard drawn, or unannealed. The process of galvanising, however, while it considerably weakens the wire, also anneals it to some extent. It is probable that iron wire, completely unannealed, would be found unsuited for the covering of cables, from its inability to resist the effect of torsion, which so often occurs through the kinking of the line.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY, BY THE SUPPRESSION OF RETARDING INDUCTION.

(Continued from page 51.)

BY RICHARD LAMING, M.R.C.S.

To sit in one's study, and perceive, with the mental eye, the electrical powers of the particles of matter and their laws, with such clearness and precision as to solve the chief difficulties of the science, is universally held to be among the things that are impossible; but for how long is it to be impossible? At one time, to say why all bodies tended to approach one another, and mentally to perceive in their particles the laws of the disposing force, was universally impossible; but at a certain epoch, the impossibility ceased, and now, after the lapse of a generation or two, we can hardly imagine why the discovery should ever have been thought even improbable. I am induced to premise this, deprecatingly, well knowing the incredulity I have to encounter in advancing, as I am now doing, a pretension that the public mind is not prepared for, and duly estimating the arrogance I shall seem chargeable with, if foregone impressions be allowed to supersede the judgment, after evidence, of those to whom I am addressing myself. If, by thus appealing to analogy, I shall obtain for my arguments a consideration in the fair spirit of criticism, I shall have no misgiving about the recognition of the truthfulness of what I am putting forward, though my manner of treating the subject may, and probably will, fall far short of doing it full justice.

The theory on which I am so confidently relying, in doing without two kinds of electricity, or the positive and negative electrical forces, comes forward with the prestige which ever attaches to the greater simplicity; and it will probably be thought in its favour, that it makes definite and unchangeable the quantity of electricity at all times attracted by matter, instead of leaving it to fluctuate with external circumstances. It gets rid, also, of other complications that have hitherto adhered to electrical theory, but which it is not necessary to mention in this place.

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PRINCIPLES OF ELECTRICAL ACTION CONSEQUENT UPON AN UNCHANGEABLE LIMIT TO ELECTRICAL ATTRACTION, SO FAR AS THEY RELATE TO THE TELEGRAPHIC CONDUCTOR AND ITS SURROUNDINGS.

As common matter and electricity, at all times and under every variety of circumstances, each attracts a certain quantity of the other, and no more, there being no excess of either in our planet, it must follow, that whenever we have on any portion of common matter more electricity than it attracts, the excess must be attracting and attracted by—in fact, virtually belonging to—some other portion of common matter; and it is equally certain, that if that other portion of common matter be in its normal electrical condition when the attraction falls upon it from without, it must, in its turn, cease to attract an equal quantity of its own electricity, which will thus be left free to appropriate to itself, by attraction, foreign common matter, to which, for the time being, it will virtually belong. And this reciprocal appropriation for maintaining electricity and common matter in their natural equivalent proportions, must take place, however far they may be separated from one another: though, of course, the attraction will always select to act at the shortest available distance, by reason of the very nature of attraction, for that term simply means any force that tends to shorten its field of action.

As there is no kind of common matter that does not naturally hold, by attraction, some greater or lesser proportion of electricity, there can be no kind exempt from this electrical action. *Any* common matter presented in its natural condition to a body in a *plus* or a *minus* electrical condition, must become the seat of a new distribution of the electrical *attraction*, whether the presented body be in the solid, fluid, or the gaseous form, whether it be an insulator or a conductor, in short, whatever be its other physical properties.

I must here introduce a note parenthetically: whether electrical insulators and electrical conductors owe their respective characters to opposite physical conditions, or to merely different degrees of one and the same physical condition, need not here be considered. It has become customary to contemplate conductors as insulators in which resistance to conduction is very small; and, on the other hand, to regard insulators as conductors opposing resistances comparatively great: I shall sufficiently make my meaning plain if, in speaking of an insulator, my remarks be taken to apply to it only so far as it is not a conductor; and if, on the other hand, what I shall adduce with respect to conductors be accepted as excluding all reference to what in hem may be insulating.

When plus electricity in a given body is attracting the common matter of any other body, being an *insulator* in its normal electrical condition, in order to appropriate to itself an equivalent quantity of that foreign common matter, the consequent liberation of electricity in the insulator is *virtual*, but not *actual*. It is virtual inasmuch as the liberated portion of its natural electricity has ceased to be attracted by the insulator; it is not actual, because, though it has ceased to be attracted by the common matter of the insulator, it cannot, being insulated, quit its normal position.

The portion of electricity which has thus become *virtually* liberated in the insulator without leaving it will be to it a plus charge; and, like the original plus charge, it also must have its equivalent of common matter somewhere, which, if it be in a natural electrical condition, must have produced in it also a corresponding plus charge.

Combining these principles with the properties of figure, the conclusion is inevitable that whenever the electrical action sets out from the surface of a plus wire in the axis of an insulating cylinder, it must be propagated outward from one cylindrical stratum of insulating particles to another, until it reaches the exterior surface; every successive stratum becoming plus under the action of its predecessor, and making plus its immediate successor.

Supposing the insulating cylinder, in which the plus wire is enveloped, to be itself surrounded by another cylinder of matter that is conducting, then the electrical action from the outer surface of the insulating cylinder must be propagated to the inner surface of the conducting cylinder. There it will undergo a change, because the liberated electricity constituting the plus charge on the inner surface of the conducting cylinder can actually pass through its substance to its outer surface, from whence it can either escape to its equivalent of minus common matter, or, if unable to pass away, recommence the electric action, to be propagated stratum by stratum, in some contiguous insulating matter,—a surrounding atmosphere for example.

But we are not to suppose, because the propagation of the electrical action, stratum by stratum, is seemingly interrupted within the mass of the conductor, that in reality it is interrupted; the nature of attraction requires that plus charge shall be successively set up in the different strata of bodies of all kinds, conductors as well as insulators; but, being thus set up in a conductor, its duration is only transient, for all the successive plus charges can instantly and simultaneously discharge themselves from stratum to stratum, leaving only the most external stratum of the conductor overcharged by the actual reception of a surplus quantity of electricity which it can pass no further.

This re-distribution, *not necessarily of electricity, but of electrical attraction* taking place both in insulators and conductors as a direct consequence of its definite nature, and leading either to conduction or charge, as the condition for one or the other may happen to be present, will be recognized by every one as answering to the electrical static induction that has been practically known for a century, and lately so successfully traced into much detail; and now, having in brief outline explained its nature, and shown that it is susceptible, on mechanical principles, of being minutely understood, I may pass on to show the magnitude of its importance to electro-telegraphy, referring those who desire to study it in other applications to what I have written upon the subject in former numbers of this periodical and elsewhere.

(*To be continued.*)

LONDON DISTRICT TELEGRAPH.

The present age certainly cannot be called one of prejudice. If there is one thing upon which we pride ourselves more than another it is on throwing away all antiquated notions of what can or ought to be and guiding ourselves solely by the evidence of our senses to that which is. And yet even in our enlightened age there yet lingers here and there some good old prejudice of more than usual toughness of constitution, before which the clearest and most ocular of demonstration is of little avail, and which impels us, *nolens volens*, to resist a change we do not hesitate to admit as an improvement.

Perhaps one of the strangest, as it is undoubtedly one of the most senseless, of these few lingering prejudices of the British mind is that which forbids, except in cases of pressing emergency, the use of the electric telegraph. With almost every other invention for the economisation of time, trouble, and money, use has long ere this rendered us thoroughly familiar. No one thinks of travelling habitually by the parliamentary train, because the breathless rapidity of the express suits only with the urgent haste of the messenger of life and death. No one crosses the Channel, whether English or Irish, in a "smack" or a "hoy" on the ground that expectant friends on the other side might be startled by their sudden appearance per Leinster or Maid of Kent. Some few, indeed, may still be found who abjure the rapid Egyptian rout towards the East in favour of the good old-fashioned voyage round the Cape of Good Hope; but even this is probably not often from the simple fear of arriving too soon at their their journey's end. It seems almost incredible that in these railroad times any one could be found who could really and deliberately reject an improved means of communication simply add solely because it is so much improved. And yet this is precisely the case with that new feature in our metropolitan system of which we propose to day to give a brief account.

The great—indeed, almost the only great—difficulty of the London District Telegraph Company, has been found in an aggravated form

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of that popular prejudice which raised such an outcry against the first introduction of steam. We say an aggravated form, because the prejudice in this case stands really upon nothing whatever but its own demerits. There is no question—as in the ignorance of those early railroad times—of damage to property or vested rights. There is no vague fear of the employment of a new and mighty power which might not impossibly prove beyond our control. There is no "coo" whose characteristic stupidity could be such a "vara serious thing" for the quiet electric wire. The difficulty is simply this. The English mind has chosen to lay it down as a law that the electric telegraph is a thing only to be used in cases of the last importance, and having once settled this point, feels bound to undergo a thrill of excitement and horror whenever the well-known red printed envelope, with its formidable injunction of "immediate" in the upper left-hand corner, is placed in its hands. It is literally true that with ninety-nine people out of a hundred, the receipt of a telegram is even now about the most startling event that can befall. Now it is difficult to imagine anything more foolish than all this. The telegraph is a mere means of conveying a message expeditiously from place to place. In London especially, it is but the medium for the conveyance in nine or ten minutes, and at the cost of 6d., a note which a messenger would charge 2s. or 3s. to deliver in the course of the afternoon.

This new London Telegraph, indeed, will probably do a great deal to remove this foolish terror, and place the electric wire in its true position as a cheap and rapid carrier of messages of every kind. The company have already taken, as we think, one very sensible step towards this most desirable end in the abolishing of those wonderful red envelopes, with their mystic emblems of fire and sword, and their imperative injunction to urgent speed. A timid old lady may have, indeed, some excuse for being startled when so threatening a document is placed suddenly in her hand; but in the plain brown envelope of the District Company, asserting only by the modest word "telegram" over the address, its social superiority over the advertising missives of "enormous sacrifices" and "universal pills," the most fearful need really find no ground for particular alarm. Already, indeed, we can perceive symptoms of an abatement in the first feelings of horror with which the metropolis and its suburbs first contemplated the introduction of this rapid mode of communication among the usages of everyday life. It is not only in the increasing number of messages that this tendency may be seen. A steady rise of cent. per cent. upon the transactions of each successive half-year, is certainly no small proof of increasing popularity. But the most evident signs are to be found in an analysis of the messages themselves. We suppose that more messages of a purely petty and domestic nature pass now in the course of one single day over the wires of the London District Company than before its establishment were conveyed by the whole magnetic apparatus of the kingdom in the course of the entire year. The mere intimations from absent husbands to their home-staying wives of impending absence from the dinner table, or sometimes—though we admit far less often—of unexpected but no doubt welcome return, occupies something like ten per cent. of the messages transmitted. Scarcely a day passes, too, without its various notices of unexpected friends to dine; its dozens of requests for the forwarding of forgotten keys; its little appointments to meet "in the old place;" its regrets that some anticipated meeting must be postponed, as so and so "has come home;" its reminders to oblivious husbands not to "forget the beer," or "the coals;" its call for the doctor, or the lawyer; its order for stalls for the opera, or "Lord Dundreary;" and half a hundred more of the little matters of everyday life. It is, indeed, in such "small beer chronicles" as these that its vocation more especially lies, and when once the community at large begin to appreciate the convenience of being able for sixpence to send messages of this sort, in less than half an hour, from Shepherds Bush to Stepney, or from Pimlico to Harrow-on-the-Hill, the company will no doubt find its hands quite sufficiently full.

It is now about two years since the London District Telegraph Company first commenced operations. They committed, we cannot but think, a very serious mistake in opening their line before possessing a sufficient number of stations to render their working of any practical utility. With only a dozen points at different parts of the town to which messages could be conveyed along the wire, and from which they must therefore perform the rest of their journey on foot, the gain of time was in most cases very small indeed, and by no means counterbalanced that *vis inertiæ* which always stands in the way of using any new machinery for ordinary work. At the present time, however, this defect has been amply rectified, and will be still more so before long. The company has now in active operation no less than 80 stations in different parts of the metropolis, which number is to be increased to 100, and probably even more, soon as the increase of receipts shall warrant the necessary outlay. Even with the present number it would, of course, be impossible for us to give any list of them; but it will be sufficient to say that they are to be found in every quarter of the town, and for the most part distributed at such intervals as to render the utmost possible amount of accomodation to the districts by which they are respectively surrounded.

The principal station is in Cannon Street, and through this all messages pass on their way from one outlying district to another. At this station is maintained a large staff of operators, as well as of boys to carry the various messages to their ultimate destination. The telegraph clerks, however, or operators, are almost all of the gentler sex, and it is highly satisfactory to find that so good and remunerative an employment has been found for that numerous class, whose sole prospect has hitherto been that most unsatisfactory of pastimes the "nursery governess." Nor need we in this case, as in some others where the attempt has been made to furnish some more agreeable occupation for this hardly-used section of society, regret that the work has been taken from those who would have done it better. The evolutions of the magnetic needle must have, we should imagine, some undiscovered affinity with its humbler namesake of common domestic life; but, however that may be, the fact is indisputable that the ladies make the best telegraph clerks, and with this additional recommendation, that their more limited sphere offers them no inducement, after the acquisition of all the skill requisite for an accomplished operator, to seek some other employment just as their services are becoming valuable. It is curious to stand in the instrument room among the eighty young ladies busily at work, and watch the different idiosyncracies as developed in the manner in which each conducts her operations. One dashes at her instrument with an impetuous rapidity that soon brings to utter grief the "washers" which confine the noise of her "plungers," without some sort of bounds, and for whose replacement she is mulcted of some portion of her weekly pay; another raps on slowly and steadily as part of the day's work to be done; here a pair of bright black eyes glistening from under a forehead, off which the hair has been pushed with a quick impatient gesture, are glittering impatiently as the little hand raps out a sharp rebuke to a stupid correspondent in some distant part of the town; there a pair of sentimental blue turns gladly from the completed message to the novel whose most exciting scene has been interrupted by an inquiry after the missing keys of some unromantic Smith or Brown; this girl is smiling or frowning over her work in evident appreciation of the message under manipulation; that plods steadily on her way, and would telegraph to the Tower the signature of her own death warrant, were such documents accustomed to pass that way, without the slightest idea that anything of particular importance had been passing through her hands. All, however, seem thoroughly comfortable, and those who are for the moment not employed are all busily occupied with book or work. Beyond the instrument-room, too, every comfort is carefullly provided. Nothing could be more complete than the conveniences for dressing, &c., of every kind; and as the nature of their employment, not unmixed perhaps with the desire to remove as far as possible any temptation to gossip, necessarily confines them to the building throughout the entire day, a very comfortable dining-room is provided, where the meals that have been cooked on the premises, or brought in the form of sandwiches, &c., ready for consumption, can be discussed at such times as the work may most conveniently allow.

It may be a question how far the plan of keeping a large staff of boys at the central terminus, and dispatching messages from thence by hand, instead of along the wires to the nearest station for delivery, will be found to answer in the long run. From a pecuniary point of view it is certainly a saving, and in the present imperfect state of the undertaking it may very possibly be the wisest plan; but in a business of this kind every minute is of importance, and when once the business has expanded sufficiently to admit of a wider diffusion of the staff of letter carriers, it will, we doubt not, be found the wiser course. These boys are paid at the rate of one penny per message, a system which is found to answer in every way much better than the former plan of regular weekly stipend. A sharp, industrious boy can average easily at this rate about 10s. a week.

The low rate charged for messages—sixpence for fifteen words exclusive of address, and half rates for prepaid answers—does not by any means affect the precautions taken for the safe keeping and delivery of the messages entrusted to the company's care. Each receives its particular and goes through its regular course from desk to desk and room to room, until its work is finally accomplished. when it is carefully put up in company with all papers—receipts, duplicates, transmitted copies, and the rest—bearing in any way upon it, and preserved for three months in one of the numerous presses close at hand, from thence to

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descend at the end of that period to the cellar, after a two years' sojourn in which it is finally destroyed.

One peculiar feature of this District Telegraph is the arrangement by which it affords to clubs and large business houses the advantages of a "private wire." At a very slight cost per mile, the company will run a special telegraph from any private house to their central station in Cannon Street. From hence all messages will be at once repeated over the wires of their London system, or further yet, along the numerous English and continental lines, with all of which they are in immediate communication. The importance of this privilege to the clubs and to the commercial world is already beginning to be appreciated. To the latter especially it is invaluable. Numerous special contracts have already been entered into by leading London firms, especially such as, like the world-famous stationers De la Rue and Co., have intimate relations on the other side of the Channel. It is no small advantage to a great mercantile house to be able from its own counting-house to telegraph their orders direct to their correspondents in almost every part of the civilized world.

Greatly facilitating the working of this private-wire system is that of contract messages. By this arrangement a subscriber of 20s. becomes thereby at once entitled to send over any portion of the company's wires one hundred messages, ordinarily charged at the rate of sixpence each, and in addition to this has the privilege of opening an account with the company, by virtue of which any messages addressed to him will be forwarded without prepayment. To London tradesmen and suburban customers this is a very great boon. Numbers of the former now take their contract tickets and send round to their customers circulars, five hundred of which are printed for them by the company on taking up the contract, stating their readiness to receive orders through the telegraph without any charge to the sender. Thus, for instance, any customer of Dakin and Co., the great tea merchants of St. Paul's Churchyard, have only to step into the nearest district telegraph office and dispatch an order for so many pounds of tea, and the trifling contract charge is readily paid by the City firm for the benefit of the order, while the purchaser, without one farthing of extra expense—indeed, at the saving of a penny—gets its tea delivered just twelve hours sooner than if he had ordered it by post. Much use, too, is made of this contract system by many London physicians, who find it often of the utmost convenience in communicating with their patients in different parts of the town. Perhaps the most singular purpose to which it had been applied is that invented by Messrs. Chubb and Co., who inform their customers that whenever they are so unfortunate as to leave the keys of their safe at home they have only to telegraph the number, without a farthing of expense, and a messenger will be instantly dispatched with a duplicate of the missing instrument.

One other great convenience the company have very recently offered to the public. The General Omnibus Company have, within the last few weeks, set up, as most of our readers will probably be aware, an "Express Parcels Dispatch;" and the Telegraph Company, by proffering the use of their stations and wires for the assistance of this project have added immensely to its utility. At almost all of their stations parcels are now received for transmission by the Omnibus Company and in respect to parcels thus transmitted the telegraph itself is, we believe, open free of charge.

In short, this most useful company has done as much almost as the postal system of the famous Rowland Hill to facilitate the internal communication of the metropolis. Owing, as we have said, chiefly to the absurd dread of "telegrams" the conveniences it proffers have met as yet with but a very partial appreciation; and up to this time no dividend has, we believe, been declared. The balance, however, between receipt and expenditure has been already attained: and as the business is, as we have stated, steadily doubling itself every half-year, the Christmas balance-sheet will, no doubt, show a satisfactory surplus.—*Standard.*

PERSIAN GULF TELEGRAPH.

CONTRACT SPECIFICATION FOR THE MANUFACTURE OF THE OUTER COVERING OF THE PERSIAN GULF SUBMARINE TELEGRAPH CABLE.

The core, consisting of 225 lbs. of copper wire, and 275 lbs. of gutta percha per nautical mile, covered with tape, will be delivered to the contractor, in lengths of about three nautical miles, at the works of the Gutta Percha Company, in Wharf Road, London. It will be tested at the time of delivery by the engineers appointed to supervise the manufacture of the cable, and after the delivery the contractor is to be responsible for any injury to it until the completed cable is removed from his works, and to make good any such injury.

The contractor is to convey the core to his manufactory without delay, upon drums provided by him of a form approved of by the engineers, and with such precautions for its protection as they shall require.

The core is to be immersed in water upon its arrival at the manufactory, and to be kept under water until the commencement of the serving process.

The joints in the core are to be made by experienced workmen. Chatterton's compound is to be used next to the conductor, between the layers of gutta percha, and outside all. In every case one joint-maker is to be employed to join the conducting wire, and another to apply the insulating covering. No joint in the core is, under any circumstances, to be made, except in the presence of inspectors who will be appointed for this duty, and who will test and pass each joint; sufficient time is to be allowed by the contractor for this operation.

Every joint is to be made as perfect in its insulation as the rest of the core, or to be rejected and cut out. Tape is to be laid over the joints in the same manner as over the core, the ends of the lapping being secured by thread.

The core is to be covered in the usual manner with a full and sufficient serving of Russian hemp, treated with Stockholm tar in such manner and proportions as required.

For the main cable, twelve number seven guage (B.W.G.) galvanized iron wires are to be laid over the cores, and serving in the usual manner; the iron to be hard drawn, of the quality known as "best, best," and free from scale and inequalities.

For the shore-end cable, twelve number two guage (B.W.G.) galvanized iron wires of the same quality are to be laid over the core and serving.

No weld is to be made in any of the iron wires within six feet of any other weld.

The cable is to be covered after the iron wires are laid on, and before being coiled into tanks, with two coatings of mineral pitch, silica and Stockholm tar in the proportions of 34, 56, and 10 parts respectively, and with two servings of tarred hemp yarn laid alternately, the first coating of the compound being next to the wires, then a serving of yarn, then compound again, and lastly, yarn. The compound is to be applied hot, and the yarn is to be laid over immediately after its application; such special precautions are to be taken against any injury to the core, in case of the machine stopping, as the engineers will direct. The yarn is to be everywhere covered by the compound, and the outside is to be smooth and regular.

The cable when completed is to be coiled under water in suitable watertight tanks, so situated that it can be afterwards, at all tides, coiled on board vessels drawing twenty feet of water. The water is to be withdrawn by the contractor from the tanks, and replaced, if, and so often as required by the engineers.

The tanks and other parts of the manufactory where the cable is manufactured or stored are to be roofed over.

Correct indicators are to be attached to each closing machine, showing the exact amount of cable to be manufactured, and the completed cable is to be marked at every nautical mile, in such manner as the engineers will direct.

A separate and convenient room for testing the cable, and suitable space for batteries is to be provided by the contractor.

Free access to the contractor's works is to be given at all times to the officers of the Government, and to the engineers and persons appointed by them to inspect the manufacture of the cable, and full liberty and facilities for examining and testing every part of the materials or manufactured cables; all materials shall be liable to rejection if found to be unfit, or not in accordance with the terms of this specification.

Every facility is to be provided by the contractor for the shipment of the cable, and no vessels are to be moored off his works during the shipment, in such manner as to interfere therewith. Fourteen days notice will be given previous to the arrival of the vessels to receive the cable.

The manufacture is to commence within twenty-one days after the tender is accepted, and to be completed within fifteen weeks after the commencement of manufacture. The amount of cable made in any week to be not less than fifty nautical miles after the first four weeks of manufacture.

Any additions or alterations in the manufacture of the cable, as described in this specification, which may be required at any time by the engineers during the progress of the work, are to be made to the contractor upon terms to be then agreed upon, or, in the event of difference, the price of such alteration is to be determined by arbitration in the usual manner.

All the materials employed are to be the best of their several kind, and to be fully approved by the engineers.

Payment will be made monthly, upon the certificate of Lieutenant-Colonel P. Stewart, or other officer appointed by the Government, for the number of nautical miles completed in accordance with this specification, less ten per cent., to be retained until the cable shall have been shipped.

A formal deed of agreement will be entered into with the contractor whose tender is accepted.

Specimens of the cables, with and without the external coating, and of the joints to be made in the core, are to be seen at the offices of Messrs. Bright and Co., Victoria-street, Westminster.

Tenders marked "Tender for Persian Gulf Cable," are to be addressed in the form hereto appended, at or before noon of the 12th December, to Lieutenant-Colonel P. Stewart, R.E., Public Works Department, India Office.

India Office, December 5, 1862.

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CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1802—YOUNG, Thomas.—

[A Syllabus of a course of Lectures on Natural and Experimental Philosophy. By Thomas Young, M.D.' F.R.S., Professor of Natural Philosophy in the Royal Institution of Great Britain. London: From the press of the Royal Institution; W. Savage, printer. Sold at the House of the Institution, Albemarle Street; and by Messrs. Cadell and Davies, Strand, 1802.]—8vo. Part the third, Physics, contains, page 150 to 161, on Electricity and Magnetism.

1803—YOUNG, Dr. Matthew.—

[An Analysis of the Principles of Natural Philosophy. By Matthew Young, D.D., S.F.C.D. (late Bishop of Clonfert.) London: Printed for J. and G. Robinson, Paternoster Row, and R. and E. Mercier and Co., Dublin, by T. Davison, White Friars, 1803.]—1 vol. 8vo., 450 pages, illustrations. Pages 397 to 450, on Electricity in general.

1803—CARPUE, J. C.—

[An introduction to Electricity and Galvanism; with cases, showing their effects in the cure of diseases: to which is added a description of Mr. Cuthbertson's Plate Electrical Machine. By J. C. Carpue, Surgeon. Being the substance of Lectures delivered to his Anatomical Class. London: Sold by A. Phillips (successor to her late uncle, Mr. Lewis), Great Russel Street, Covent Garden; Longman and Rees, Paternoster Row; Cadell and Davies, Strand, 1803.]—8vo., 112 pages, plates.

1803—ALDINI, John.—

[An accouut of the late improvements in Galvanism, with a series of curious and interesting Experiments performed before the Commissioners of the French National Institute, and repeated lately in the Anatomical Theatres of London. By John Aldini, Professor of Experimental Philosophy in the University of Bologna, &c. To which is added an appendix, containing the Author's experiments on the body of a malefactor executed at Newgate, &c., &c. Illustrated with engravings. London: Printed for Cuthell and Martin, Middle Row, Holborn, and J. Murray, No. 32, Fleet Street, 1803.]—4to., 221 pages.

1803—BIRCH, John.—

[An Essay on the Medical Application of Electricity. By John Birch, Esq., Surgeon Extraordinary to His Royal Highness the Prince of Wales; and one of the Surgeons of St. Thomas's Hospital. London: Printed by W. S. Betham, Furnival's Inn Court, Holborn, for J. Johnson, St. Paul's Church; B. Crosby, Stationers' Court; Callow, Crown Court, Soho; and Murray and Highly, Fleet Street, 1803.]—4to., pam., 57 pages.

1803—ALDINI, John.—

[An account of the Galvanic Experiments performed by John Aldini, Professor of Experimental Philosophy in the University of Bologna, &c. &c., Member of the Medical and Galvanic Societies of Paris, &c.,—on the body of a malefactor executed at Newgate, Jan. 17, 1803. With a short view of some Experiments which will be described in the Author's new work now in the press. London: Printed for Cuthel and Martin, Middle Row, Holborn, by Wilks and Taylor, Chancery Lane, 1803.]—Pam., 8vo., 86 pages.

1804—IZARM, Joseph.—

[Manuel du Galvanisme, ou description et usage des divers Appariels Galvaniques employés jusqu'à ce jour, tant pour les Recherches Physiques et Chemiques que pour les applications Medicales. Par Joseph Izarm, Professeur de Physique de la Société Libre des Sciences, Lettres et Arts de Paris, de la Société Academique des Sciences, de la Société Galvanique, et chargé par elles des Cours que font partie des ses Séances. A Paris: Chez J. F. Barrau, Libraire, Quai des Augustins, No. 33, Dumotiez, Jabricant d'instrumens de Physique, Rue du Jardenet. Anno 1804.]—1 vol., 8vo., plates, 293 pages.

1804—ALDINI, Jean.—

[Essai théorique et experimental sur le Galvanisme, avec une série d'expériences faites en presence des Commissaires de l'Institut National de France, et en divers Amphithéatres Anatomiques de Londres. Par Jean Aldini, Professeur de l'Université de Bologna, &c. Avec Planetus. Paris: de l'Imprimerie de Fournier Fils; chez les Frères Picanoti, Place du Tribunal, No. 1354; Joseph Lucchesini, Libraire, à Bologna, MDCCCIV.]—8vo., 2 vols. First vol., 346 pages; II., 330 pages, numerous plates. Contains a great number of experiments on the effect of electricity on dead bodies, &c.

1804—WILKINSON, C. H.—

Elements of Galvanism in Theory and Practice, with a comprehensive view of its history from the first experiments of Galvani to the present time. Containing, also, practical directions for constructing the galvanic apparatus, and plain systematic instructions for performing all the various experiments. Illustrated with a great number of copper-plates. By C. H. Wilkinson, Lecturer on Galvanism in Soho Square, Member of the Royal College of Surgeons, &c. In two volumes. London: Printed for John Murray, 32, Fleet Street, 1804.] —8vo., 2 vols.; I., 468 pages; II., 472 pages; plates.

1805—SUE, P. Ainé.—

[Histoire du Galvanisme, et analyse des differens ouvrages publiés sur cette découverte, depuis son origine jusqu'à ce jour. Par P. Sue Ainé, Professeur, &c., &c. Seconde édition. A Paris: chez, Bernard, Libraire de l'Ecole Polytechnique, et des Ponts et Chaussées, Quai des Augustins, No. 31, 1805.]—8vo, 4 vols.: Vol I., 335 pages; II., 492 pages; III., 379 pages; IV., 362 pages.

1806—BRYAN, Margaret.—

[Lectures on Natural Philosophy: the result of many years' practical experience of the facts elucidated. With an Appendix containing a great number and variety of Astronomical and Geographical Problems; also, some useful Tables, and a comprehensive Vocabulary. By Margaret Bryan. London: printed by Thomas Davison, Whitefriars; and sold for the authoress by George Kearsley, Fleet Street, and James Carpenter, Old Bond Street, 1806.]—4to, 388 pages, plates. Lecture the Seventh, on Magnetism from p. 143 to 159; Lecture the Eighth and Ninth, on Electricity, p. 161 to 214.

1807—HANY, M. R. J.—

[An Elementary Treatise on Natural Philosophy, translated from the French of M. R. J. Hany, Professor of Natural History at the Museum of Natural History. By Olinthus Gregory, A.M., of the Royal Military Academy, Woolwich; with Notes by the translator. London: printed for George Kearsley, Fleet Street, 1807.]—M., 2 vols, 8vo., 862 pages. Numerous Plates. Part V. in the first volume on Electricity, and Part VI. in the second volume on Magnetism.

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1808—GERBOIN, Ant. Cl.—

[Recherches Experimentalis sur un Nouveau mode de l'actier Electrique. Par Ant. Cl. Gerboin. Professeur à l'Ecôle speciale de Medicine de Strasbourg, &c.; avec une Planche en Taille-douce. Strasbourg: chez, F. G. Lirrault, Imprimeur Libraire, 1808.—8vo., 356 pages, plates.

1809—VEAU DELANNAY, Claude—

[Manuel de l'Electricité comprenant les principles èlémentaires, l'Exposition des systêmes, la description et l'usage des differens Appareils électriques, avec l'Exposé des Méthodes Employées dans l'Electricité Medicale; suivi d'une Table Chronologique de tous les ouvrages relatifs à l'Electricité. Par Claude Veau-Delannay, Docteur de Medicine, &c.,&c. Paris: chez, L. Duprat-Duverger, un des Grands-Augustins, No. 21, l'Auteur rue de Seine, No. 6, MDCCCIX.]—8vo, 272 pages, plates. This work contains a valuable list of works on Electricity, prior to 1809; also a list of articles on Electricity, which appeared in the *Journal de Physique* to that date.

1810—YATMAN, Matthew—

[A Familiar Analysis of the Fluid capable of producing the Phenomenon of Galvanism, Electricity, or Combustion, with some remarks on Simple Galvanic Circles, and thir influence upon the vital principle of Animals, illustrated bp the Theories and Experiments of Galvani, Garnet, Davy, Young, Thomson, &c., &c. By Matthew Yatman. London: printed by G. Hayden, 4, Brydges Street, Covent Garden, and sold by G. Kearsley, Fleet Strset; Cadel and Davis, Strand; J. Callow, Crown Street, Pr nces Street, Soho; Mudie, Chelsea, and all booksellers, 1810.]—1 vol. 8vo.

PHYSICAL SCIENCE.

On the Spectrum of the Electric Spark in Compound Gases, and particularly in Fluoride of Silicium, by M. J. M. SEGUIN.

WHEN the spark traverses fluoride of silicium in a tube inversed over mercury it produces a very beautiful blue light. This colour shows in the spectrum as a large, bright blue ray, far removed from the green.

Fluoride of boron, containing, it is true, some traces of fluoride of silicium, gives the same effects, and a similar blue ray.

It seems admissible to attribute this distinct blue ray of the spectrum to fluorine, as M. Plücker does not mention it among those he has observed in the rarefied vapour of chloride of silicium. The rays seen by M. Plüker were one red, one orange, three green, and one blue; three proceeding from chlorine, the others, probably, from silicium. In the saturated vapour of the same compound I have also observed two red or orange rays, three green and one blue, or rather violet, the blue being very brilliant, but lighter than that of fluoride of silicium, and very near the green.

Enclosed alone in a narrow tube, and submitted to the influence of a series of sparks some millimetres long, between two platinum wires, fluoride of silicium, after more than an hour, is not sensibly decomposed. In the first few moments some vapour and a white deposit are formed, arising, probably, from the remains of humidity, but they do not increase. After the first period the volume of gas remains invariable. Decomposition and successive combinations, no doubt, take place.

Mixed with hydrogen, fluoride of silicium decomposes rapidly. The latter gas being in excess, the hydrogen rays gradually fade. Under a platinum crucible, serving as a receiver, the reaction absorbs twice as much hydrogen as fluoride, and the sides of the crucible are covered with a dark grey coating. In glass tubes the reaction is complicated by the hydrofluoric acid attacking the glass. Two volumes of hydrogen generally disappear for one volume of fluoride, and against the tube a buff-coloured solid product is deposited in layers or flakes, which burns with a little explosion, and which, heated in the tube where it is formed, disengages hydrogen nearly to the amount of that which had disappeared over and above the two volumes. These properties, and some others, are not sufficient to prove the identity of this product; I trust that a more powerful induction apparatus will admit of my collecting a quantity sufficient for analysis.

The decomposition of fluoride of boron mixed with hydrogen produces liquid drops, with a light blackish deposit.

The appearance of the spark is generally an evidence of its chemical action. When it passes without occasioning any reaction, it is slight, and the rays of the spectrum are then very defined; and the rays are less distinct, and are enveloped in an aureola, when there is decomposition or combination. However, the distinctness is increased by multiplying the solutions of continuity in the discharge-conductors, while the voluminousness of the spark is increased by adding a weight to the hammer of the contact-breaker. The change from the thin spark to the voluminous form indicates that the reactions are at an end. In the decomposition of strongly-carburised gas, the spark resembles a flame, and, probably on account of the large number of fragments of incandescent carbon, the spectrum appears continuous to the naked eye, like that of the white part of an ordinary flame. When the gas is mostly decomposed, the hydrogen disengaged, and the carbon deposited on the electrodes, the spark is small, and hydrogen rays become visible in it, as well as other rays, belonging either to carbonised hydrogen or to the carbon itself. In interpreting many experiments, it would be advisable not to overlook these observations. —*Comptes Rendus.*

"CHALK YOUR BOBBINS."

EVERY one knows that old Sir Robert Peel, father of the late prime minister of England, and grandfather of the present baronet, made his money by the cotton spinning. In the early part of his career, his business was not remarkably extensive, but suddenly he made a tremendous start, and soon distanced all his rivals. He grew immensely rich, as we all know, but we do not all know the lucky accident to which he was indebted for his enormous wealth.

In the early days of the cotton spinning machinery, a great deal of trouble used to be caused by filaments of cotton adhering to the bobbins or tapes which then formed portions of looms. These filaments accumulating soon clogged the wheels and other parts of the machinery, and rendered it necessary that they should be cleared, which involved frequent stoppages, and much loss of time.

The great desideratum was to find out some plan of preventing this clogging by the cotton, and Sir Robert, or Mr. Peel as he was then, spent vast sums in experiments. He employed some of the ablest machinists in the kingdom—among them James Watt—who suggested various corrections, but in spite of all they could do, the inconvenience remained—the cotton would adhere to the bobbins, and the evil appeared to be insurmountable.

Of course, these delays seriously affected the wages of the operatives, who, on Saturdays, generally came short in proportion to the stoppages during the previous days. It was noticed, however, that one man always drew his full pay—his work was always accomplished—in fact, his loom never had to stop, while every other in the factory was idle. Mr. Peel was informed of this, and knew there must be a secret somewhere. It was important that it should be discovered if possible.

The man was watched, but all to no purpose; his fellow workmen tried to "pump" him, but they couldn't; at last Mr. Peel sent for the man into his private office.

He was a rough Lancashire man—unable to read or write—little better indeed than a mere animal. He entered the "presence" pulling his forelock, and shuffling on the ground with his great clumsy wooden shoes.

"Dick," said Mr. Peel, "Ferguson, the overlooker, tells me your bobbins are always clean, is that so?"

"Ee's master, 't be."

"Well, Dick, how do you manage it—have you any objection to let me know?"

"Why master Pill, 't be a sort o' sacret loike, ye see, and if oi told, t' others'd know 's moch as oi," replied Dick, with a cunning grin.

"Of course, Dick, I'll give you something if you will tell me—and if you can make all the looms in the factory work as smoothly as yours."

"Ev'ry one 'n them, master Pill."

"Well, what shall I give you? Name your price, Dick, and let me have your secret."

Dick grinned, scratched and shook his great head, and shuffled for a few minutes, while Mr. Peel anxiously awaited his reply. The cotton lord thought his servant would probably ask a hundred pounds or so, which he would most willingly have given him. Presently Dick said:

"Well, master Pill, I'll tell 'ee all about it, if you'll give me—a quart of beer a day as long as I'm in the mills—you'll save that ten."

Mr. Peel rather thought he should, and quickly agreed to the terms.

"You shall have it, Dick, and a half gallon every Sunday into the bargain."

"Well, then," said Dick, first looking cautiously around to see that no one was near—"this it be," and putting his lips close to Mr. Peel's ear he whispered;—"Chalk your bobbins!"

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That indeed was the great secret. Dick had been in the habit of furtively chalking his bobbins, which simple contrivance had effectually prevented the adherence of the cotton. As the bobbins were white, the chalking had escaped detection.

Mr. Peel was a sagacious man, and saw through the affair at a glance. He at once patented the invention—had "chalking" machinery contrived, and soon took the lead in the cotton spinning department. This was the foundation of his princely fortune. It is but right to add that he pensioned off Dick handsomely.—*Scientific American.*

THE ELECTRIC LAMP IN LIGHTHOUSES.

FOR the last five or six years the maritime world has been waiting with some anxiety for the termination of certain experiments respecting the employment of the electric light as a beacon. These experiments are well-nigh concluded, and the question whether the old oil-lamp is to be superseded by the electric lamp will be speedily determined.

Early in 1857, experiments were made on the subject at Blackwall and Woolwich by Prof. Faraday and Prof. Holmes, and subsequently the latter was requested by the Elder Brethren of the Trinity House to prepare a plan for employing the new light. This plan was submitted to Prof. Faraday, who reported favourably upon it, and the result was that the Trinity Board sanctioned the establishment of an electrical apparatus in the South Foreland Upper Lighthouse. This apparatus consisted of an accumulation of powerful magnets and iron cores with surrounding coils, accurately arranged, so that when the associated cores were revolving they sent all their currents into one common channel, from whence they were conveyed to the lantern by conducting wires, and there produced the electric light. There was no consumption of material or energy, other than that of the burning fuel required at the steam-engines to produce motion.

A trial of the light began in the lighthouse on the 8th of December, 1858; but as the apparatus was imperfect in some points, and the results unsatisfactory, the lighting by the apparatus was suspended for a while, that the defects might be remedied. The lighting was renewed in March, 1859, and during the following month it was carefully examined by Prof. Faraday. In his subsequent Report to the Trinity Board, after describing very fully the observations he made at sea, and the various experiments dy which he tested the power of the light, he states his opinion that Prof. Holmes had practically established the fitness and sufficiency of the magneto-electric light for lighthouse purposes, so far as its nature and management are concerned; that the light produced was powerful beyond any other that he had seen so applied, that its regularity in the lantern was great, and its management easy. Ten months after he had thus expressed his approval of the experiment, he again visited the light, and found it of the same character as when he had last seen it. It was generally very steady, but with slight interruptions now and then from iron in the carbons. He found that it had a tendency to sudden and spontaneous extinction, arising either from the breaking off of the end of the carbon, or from some disarrangement in the fine mechanical work of the lamp. This happened three or four times every night; and being once extinguished, the lamp did not re-light of itself. The slightest touch of the keeper's hand, however, was enough to restore the light; but the liability to temporary extinction occasioned an anxious watchfulness on the part of the attendant, who was constrained on this account to stay in the lantern continually. The light had never been stopped by any deficiency of action in the machine-room.

The appointed time during which the magneto-electric light was to be placed under practical trial at the South Foreland having, early in 1860, come to an end, Prof. Faraday urged the Trinity House to authorize its application, either there or somewhere else, for a further and a longer period, stating that it had proved to be practical and manageable, and had supplied the means of putting into a lighthouse lantern, for six months or more, a source of illumination far surpassing in intensity and effect any other previously employed. Acting on this suggestion, the Trinity Board established an electric light at Dungeness. At this lighthouse it is placed in an optic apparatus constructed especially for it, which is only 16 inches in height, and 14 inches in external diameter. The apparatus consists of six lenticular zones and seven reflecting zones; of the latter three are below and four above. At the South Foreland there was one elcctric lamp placed in the centre of a Fresnel optic apparatus. Here there are two of the new optic apparatus, placed one over the other in the axis of the lantern, and four electric lamps: for each apparatus two, only one lamp being used at a time. Mr. Holmes includes in his plan the use of all these lamps and apparatus, because of the facility of rapid change in the lamps and carbons, and they cause no alteration in the magneto-electric machines, wires, or engines, which are the same as were employed at the South Foreland.

Beside the electric apparatus, the light from which passes through the upper panes of the lantern, the original reflectors and their lamps are retained in place, so that they can be at once substituted for the electric light if any accident or failure should occur to the latter, and also may be used in conjunction *with* the electric light in a comparison of one with the other.

In one of his Reports on the Dungeness light, written during the present year, Professor Faraday mentions an interesting experiment. Arrangements were made on shore (Mr. Holmes being in charge of the light), by which observations could be taken at sea about five miles off, on the relative light of the electric lamp and the metallic reflectors with their Argand oil lamps. At the given distance the eye could not separate the two lights, but by the telescope they were distinguishable. The combined effect was a glorious light up to the five miles; then, if the electric light was extinguished, there was a great falling off in the effect; though, after a few moments' rest to the eye, it was seen that the oil lamps and reflectors were in their proper state. On the other hand, when the electric light was restored, the illumination became again perfect.

Then, whilst both were in action, the reflectors were shaded, and the electric light left alone; but the naked eye could see no sensible diminution; nor when the reflectors were returned into effectual use could it see any sensible addition to the whole light power; though the telescope showed that the alteration in the lantern had taken place at the right time. Such was the power of the electric light, that the addition or subtraction of the light of a fully effective set of reflectors, with their lamps, would not have been sensible to a mariner, however observant he might have been.

Professor Faraday enumerates some points which are against, and others in favour of the light. In the first place, the simplicity of the present system is very great, compared with that of the electric light: only two keepers are required to a lighthouse; they need possess no special knowledge; ordinary attention is all that is necessary; and thus failures of the light are almost impossible. In the new system, a second set of men will be required to attend the engines, and there must be amongst them one or more who understand the principle and construction of the lamp in the lantern, of the mauneto-electric machines, the steam-engines, and the condensers, and be able to make effectively the repairs necessary to the apparatus. In the next place, the expense of the new system must be large, compared with that of the present system. Other objections have been made, of which Professor Faraday cannot see the force; namely, that the light is too bright,—that it gives a false impression of the distance of the lighthouse,—and that it blinds the eyes of the mariners to the perception of the light on board vessels between it and them. These objections, he says, if they have any force, must be judged by mariners themselves.

The points in favour of the magneto-electric light are strong and clear in relation to the increase of light. In cases where the light is from lamp-flames fed by oil, no increase of light at or near the focus or foci of the apparatus is possible beyond a certain degree, because of the size of the flames: but in the electric lamp, any amount of light may be accumulated at the focus and sent abroad, at, of course, an increased expense. In consequence of the evolution of the light in so limited a focal space, it may be directed seaward, diverging either more or lese, or in a vertical or horizontal direction, at pleasure, with the utmost facility. The enormous shadow under the light produced by the oil-flame burner, which absorbs and renders useless the descending rays to a very large extent, does not occur in the magneto-electric lamp; all the light proceeding in that direction is turned to account; and the optical part of the arrangement, whether dioptric or reflecting, might be very small in comparison with those in ordinary use.

With reference to the final experiment now taking place at Dungeness, though Professor Faraday thinks that many changes might be made in the size, arrangement, and adjustment of the optic apparatus, he reserves these points for longer and future consideration, aided by the instructiou that will arise from the results of experience.—*Athenæum.*

BAKEWELL'S COPYING TELEGRAPH.

MR. BAKEWELL was the first who accomplished the feat of constructing an electric telegraph which should reproduce, at a distant station, a fac-simile of a message written at the sending station. The principle of his telegraph was as follows:—The message was written on a sheet of metal in some non-conducting ink, such as red sealing-wax varnish. The metal sheet was then put in connection with the line wire, and moved in a circular or spiral manner beneath a metal style, which was connected with the positive pole of a voltaic battery, the negative

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pole being put in communication with the earth. At the receiving station a sheet of chemically prepared paper placed on another metal sheet was moved in a similar manner under an iron style; the style being in connection with the line wire and the metal plate with the earth. From this description it will readily be understood that, as long as the style at the sending station was in contact with the metal sheet, a current of electricity would traverse the circuit, decomposing the salt in the paper and producing a line; but when the style at the sending station was passing over the varnish no current would circulate, and no mark would be made at the receiving station. A number of parallel lines thus traced on the paper with spaces corresponding to the varnish on the plate at the sending station, would reproduce in white on a ground of blue lines whatever might have been traced on the metal plate.

This system, although beautiful and ingenious, has not been found a commercial success, and has fallen into disuse; but it has been resuscitated with some modifications by the Abbé Casselli within the last year. He uses a relay and a local battery so arranged that when a current is circulated from the distant station the local battery is thrown out of circuit, and when the current ceases the local circuit is completed and the style marks the paper; the writing is thus reproduced in blue on a white ground.

ELECTRO-MAGNETS.

The laws which govern the forces of electro-magnets have been investigated by Messrs. Lenz and Jacobi, and also by Mr. Müller:—

If M denotes the magnetic force of the electro-magnet.
n the number of convolutions of wire.
d the diameter of the soft iron core.
Q the quantity of electricity in circulation.
and c a constant multiplier.

$$M = c\, n\, Q \sqrt{d}$$

This law only holds good for bars of iron, whose length is considerably greater than their diameter, for feeble currents of electricity, and under the supposition that the number of convolutions of wire is not so great as materially to diminish the influence exercised by the outer coils upon the bar of iron. These conditions are fulfilled in the electro-magnets usually employed for telegraphic purposes.

It will be noticed in the above formula that M increases directly as Q and as n; but Q decreases as n increases, supposing the electro-motive force to remain constant. Hence it is evident that a certain proportion between the resistance of the wire and that of the remaining portions of the circuit must be preserved to obtain the maximum magnetic force.

This relation has been found to be the following, viz.:—"When the resistance of the coils of the electro-magnet is equal to the resistance of the rest of the circuit, *i.e.*, the conducting wire and the battery, the magnetic force is a maximum."

The mathematical investigation of these laws may be found in Gavarret's 'Télégraphie Electrique.'

In practice it is usual to give the coils of the electro-magnets, influenced by the currents of the main lines, a resistance of about 120 miles, using No. 36 copper-wire; for the electro-magnets set in action by local batteries a thicker wire is used, giving a resistance of from 2 to 4 miles; but the thickness of the wire and the number of convolutions should be made in special cases according to the above laws.

It is very important that the best wrought-iron should be used in the cores of electro-magnets, otherwise a considerable amount of magnetic force remains after the current ceases. This residual magnetism can seldom be entirely destroyed, but the more pure and perfectly decarbonised the iron the less is it perceptible. To guard against this evil, it is necessary that the armatures of electro-magnets should be very carefully adjusted so as not to *touch* the poles of the soft iron cores, and this more especially when the armatures are of magnetised steel, as is often the case. A thin piece of paper is sometimes inserted between the poles of the electro-magnet and its armature, or stops are fixed in the face of the magnet to prevent contact.—*Aide-Memoire of Military Sciences.*

The Student.

THERMO-ELECTRICITY—(*continued.*)

CURRENTS IN CIRCUITS OF ONE METAL.

It was discovered by M. Magnus that when a wire, one half of which is annealed, and the other half hardened by hammering or any other means, is heated near the junction of the hardened with the soft portion, a current of electricity is invariably produced, and may be rendered evident by connecting the two extremities of the wire to a galvanometer. The same effect takes place, though to a less extent, when other metals are employed in a similar manner. A current, probably also due to a molecular change in a portion of the metal, was obtained by M. Becquerel, simply by twisting a wire into a knot, or a spiral, and heating it in proximity to the twisted portion. It was, however, observed by M. Gangain that the current is not produced when contact is avoided between any two consecutive turns of the spiral, or when, in the knotted wire, the portions which cross each other do not touch.

M. Magnus has established, by a great number of careful experiments, that no electrical effect is produced when a clean and homogeneous wire is heated at any point of its length. This applies not alone to wires of equal diameter, but also to those in which a portion has been reduced by turning in the lathe. It was found that no current could be generated by heating the point of junction of the thin and thick portions of the wire.

In experimenting with a delicate astatic galvanometer, it is often found that the mere contact of two wires, of copper for instance, attached to the terminals of the coil, occasions a strong deflection. In this case it may safely be assumed that the wires, though apparently of the same nature, differ in their chemical composition, and also that their temperature is unequal. If a wire of best English copper be attached to one terminal of the galvanometer, and one of Spanish copper (Rio Tinto) to the other, the needle may be deflected to 90° by bringing one of the wires, previously slightly warmed, into contact with the other wire. Upon this thermo-electric effect may be based a ready mode of testing approximatively the purity of various samples of wire.

The following experiment, due to M. Becquerel, may be regarded as an exception to the general conclusion arrived at by Magnus. Two wires of platinum, cut from the same length, are attached to the terminals of the galvanometer, and their free extremities in each case are coiled into a spiral. When one of the spirals is heated in a spirit lamp, and placed upon the cold spiral, the needle of the galvanometer is immediately deviated; the current being in the direction from the heated to the cold spiral. The effect is produced by alternately heating both spirals, and is consequently not due to one of the wires being *annealed* by heat. Under these conditions, therefore, a thermo-current is produced in a circuit of one metal in which the conductor is homogeneous, and of the same chemical composition throughout. When a portion of oxide intervenes between the two unequally heated extremities of a wire, a current is also produced.

Recently, some interesting observations upon thermo-electric currents in circuits of one metal have been made by Mr. Fleeming Jenkin. The currents obtained were of far greater tension than those produced by ordinary thermo-electric combinations, and are dependent upon conditions to which we shall presently refer.

A thermo-electric circuit, similar to that which has been described as bismuth and copper, may be formed by casting a frame or rectangle of antimony and mounting it upon a wooden stand. A magnetic needle may be pivotted within the frame, or a double astatic needle, as in the former case, may be made to indicate the current. This is produced by heating the metal on either side of what are termed the "neutral points" in the circuit. These neutral points are discovered by passing the flame of a spirit lamp slowly round the rectangle of metal, a current occurs when the heat *approaches* any of the points in question, and the direction of the current is reversed when the flame has traversed, and *recedes* from these points. In circuits of antimony the current always traverses a neutral point in the direction from the heated to the cooler portion. In rectangles of fused bismuth, the current is from the cold to the heated portion.

It has been observed by M. Matteucci, that these neutral points, at which the electro-motive force is generated, do not occur in rectangles or prisms of antimony or bismuth which have been slowly cooled, and in which the crystallisation of the metal is regular. A section of the metal shows that, at these points, irregular crystallization, different from that of the other portions, has taken place. In this case therefore we have a circuit of one metal, of the same chemical nature throughout, but varying in its molecular structure.

We now come to a different class of phenomena, to the study of which we may direct particular attention; as there are sufficient grounds for believing that important practical results may be obtained in this direction. Although the substance of the following experiments were published many years since, by Dr. Andrews, in the London and Edinburgh *Philosophical Magazine*, very little attention appears to have been given to this branch of thermo-electricity.

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To the terminals of the coil of an astatic or other delicate galvanometer, attach two wires of copper, to the free extremities of which are fastened short lengths of platinum wire. Heat to redness, in the flame of the blow pipe, one of the platinum extremities, and plunge it into powdered borax. Fuse the salt, and take up fresh portions, repeating the operation until a globule has been obtained, which will adhere to the end of the wire. Now bring the *cold* platinum wire into contact with the fused salt upon the *heated* platinum. The needle of the galvanometer will be deflected with some violence; and it will be found that the current, unlike that produced by ordinary thermo-electric combinations, is of sufficient tension to produce a deflection when a very considerable resistance has been inserted in the circuit.

Support the wire carrying the globule over the flame of a spirit lamp, so that the globule may slightly project beyond the flame. Bring the other wire, attached to a suitable support, into contact with the fused salt. A *permanent* current will then be produced, which, however, will be proportionate to the difference of temperature maintained in the wires.

A number of couples of this description may be arranged in series, for the purpose of obtaining greater tension, in the following manner. Fuse a globule of borax at one of the extremities of a platinum wire, a few inches in length. Arrange the terminal wire of the galvanometer as before, over the flame of a spirit-lamp, so that globule No. 1 may become fused. Attach the short platinum wire to a support of wood, and bring its uncovered extremity into contact with globule No. 1. Now, by means of a second spirit-lamp, fuse globule No. 2, upon the short wire, and bring the second terminal wire of the galvanometer into contact with it. We have here two couples, and it is easy to perceive that a greater number may similarly be arranged. The couples partake both of the character of voltaic and of thermo-electric elements, the salt, which becomes a conductor when fused, being a true electrolyte, though the voltaic effect is originated, not by chemical action, but by the difference of temperature in the wires. With four couples arranged as above, acidulated water is decomposed, although, from the small size of the elements, the evolution of gas takes place but slowly.

(*To be continued.*)

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TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic, A.	100	55 to 58	——
20	Do. B 7 per cent. till 1862	—	——	——
Stock	Electric Telegraph	100	100 to 103	——
25	Do. New		——	——
5	London District Telegraph	4½	4 to 3 dis.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered	all	⅜ to ½	——
10	Do. „	all	4 to 5	——
2	Telegraph to India	1	⅝ to ¾ dis.	——
5	United Kingdom Telegraph	8	¼ dis. to ½ pm.	——

THE LAST DAYS OF THE ATLANTIC TELEGRAPH.

WRITTEN BY ITSELF.

LIKE little epicurean juveniles, who leave the *bon-bouche* of their feasts to be eaten the last, I have left this, the most racy part of my life's history, for the finish of my narration. It is the most important feature of my whole career, not excepting the one I have described in the attempt to submerge me across the Channel, in 1850, to which, indeed, in many points, it has a great similitude. There, the means adopted to fit me for my destination were inadequate to the end, and could produce nothing but failure; here, the same. There, it is alleged that I articulated a few words at night, which were duly recorded in Roman type, but on the followiug morning was found to be—defunct. In the present instance the same allegation has been made, with this difference, however, that here, I am represented to have lingered in a doubtful state of existence for nearly a month, and that during this period of syncope previous to death, I exhibited short intermitting throes of vitality, under which I gave utterance to whole sentences, which were recorded, but not in Roman type. The doctors and nurses were called in to examine me, some of whom reported that the seat of my disorder was only about ten or twelve miles off, I presume in my throat, while others stated that it was in a more remote part of me, about two hundred and eighty miles off. There is no doubt that they were all right, seeing that I was diseased throughout, and expired from general debility. The similitude is again apparent in other points. In both cases it has been given out that the attempts have been successful, in opposition to the facts, showing in the most unmistakeable manner the very reverse; and in both instances have these alleged successes been made the pleas for soliciting the aid of Government, and modestly asking, in this, a grant of money, and in the former, a monopoly. It is to be hoped that the similitude will be equally apparent in the results of these applications. I am no advocate for monopoly of any kind, either by grants of money or exclusive privileges. Even under the most favourable circumstances it is objectionable; but in my case it is especially so. My very existence depends upon my proper adaptation to my ocean home, and I am of such an extremely fragile nature, that the slightest flaw in my construction, or error in my submersion, is fatal to it. The full and perfect knowledge of me and my requirements, the utmost care and attention to my formation, and the practical acquaintance with the element to which I am destined, and the mode of placing me therein, are absolutely necessary to my success, and these can best be obtained by leaving me open to the fair and honourable competition of skill and science; but once consign me to the exclusive power and management of incapacity, and no other result can be anticipated than failure to my consignee, and destruction to me. Such has been the case in the Channel, in the Mediterranean, and now, in the Atlantic.

With regard to the Atlantic scheme, however, Mr. Buckstone, of the "Haymarket," has been more fortunate than the Directors, for there he has most successfully introduced me in the *Spirit of the Waters*, and having now become inured to mishap and disaster, by so many and repeated failures, I can enjoy a good joke, especially as the satire is not levelled at me, but against those under whose mismanagement I have been so cruelly treated. As to the commercial value which one of the characters in this extravaganza attaches to the shares of the Company, this is a question in which I am not in the least interested. He may be, and, indeed, is right, in his estimate of the worth of the shares. It cannot be expected that, in the useless state in which I now am, I can be of any marketable value. To resuscitate me is utterly out of the question; and as to the prospect of recovering me, and the costly materials of which I am composed, it is a hopeless one. Could that be accomplished, then indeed the Shareholders might realise a trifle from my wreck, in the shape of "salvage;" but I would recommend them to bear in mind the admirable recipe of that respectable old lady, Mrs. Glasse, for cooking a hare,—"first catch your hare"—before they indulge in pleasing anticipations of any beneficial results from this source. The bear must be caught and killed before his skin can be divided; and as to the prospect of catching me, and dividing my skin, that has already been shown, in the attempt to recover me after the first failure, in 1857, when, although not four hundred miles of me were submerged, only between fifty and sixty miles were regained, and these at a cost almost, if not quite, equivalent to their value. But to proceed.

When I became acquainted with the fact that my services were to be put in requisition across the Atlantic, my first feeling was that of joy. I knew my power, and was pleased at the thought that I was about to be applied to a purpose so beneficial to the social and commercial interests of the denizens of the New and the Old World. But when I ascertained under whose auspices this achievement was about to be attempted, and the details of the plan hit upon to accomplish it, this feeling of joy was speedily changed to that of sorrow. I foresaw my fate, and the result has shown that I was not wrong in my anticipation. The progress of the scheme, from its first announcement to its repeated and final failures, has been marked with so much of the absurd and ridiculous, that, notwithstanding my annoyance and vexation, I have been considerably amused, and compelled to laugh in spite of myself. No members of the "Mutual Admiration Society" could have bespattered each other with more fulsome laudations than some of these gentlemen did at their public and private gatherings. Poor *Gil Blas* was easily cajoled by a designing knave into a belief that he was the eighth wonder of the world. There was no need of any cajolery here; to all appearance, instead of being the eighth wonder, they considered themselves the only one. As for me, I was totally ignored, a "mere cypher in the great account." It has been related, that upon the death of one of the Emperors of China, without issue or kindred, the Council of the empire waited on a certain individual, to beg that he would accept the throne: he requested that they would call on the following day, and he would then be prepared

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with his decision. When they again waited on him, to their surprise he declined the proffered honour. Upon being asked why he objected, he stated that he would willingly become their Emperor, but he objected to call the sun and moon his brothers. Being, however, pressed to reconsider his decision, the matter was ultimately arranged by his accepting the throne, upon the condition that the sun and moon should not be considered his brothers, but looked upon merely as poor relations.

It is in this light in which I must have been viewed by these gentlemen. One of them, indeed, would, as I have described, wish to claim me as his own; but no step son, or poor relation, could have been more neglected, or more cruelly treated by any inflated kinsman, than I was by these would-be wonders. When I was landed like a half-drowned cat, to which animal I have, upon one point, at least, a great resemblance, that is, in having a multiplicity of lives, and while I was in a most pitiable condition, hovering between life and death, they were being *féted*, and receiving ovations like "conquering heroes;" there was no necessity to bid any one to "sound the trumpets," they sounded their own trumpets, and loudly, too—while they were invited to banquets, at which they were feasted to their hearts' content:

"And didn't they gobble, and didn't they stuff,
And were they not sorry they hadn't enough?"

I do not mean of the creature comforts; they partook, no doubt, largely of these, and without being surfeited; but I speak of fare more suitable to their palates—whole dishes of adulation, plentifully garnished with praise and flattery, with which they were crammed. While all this rollicking was going forward, I was left in a dying state, neglected and deserted—they all, with one exception, fled from me as from a pestilence; that exception is the ELECTRICIAN. That gentlemen came to me in the hour of my affliction; and while I was deserted by others, and left to my fate, endeavoured to restore me to a better sanitary condition. I need not say, that his exertions were unavailing. From the first moment of his attendance, after feeling my pulse, he must have known that my case was hopeless. My pulse, unlike that of human beings, is not denoted by its beatings, but by its degrees of deflection. When I am in a hale and healthy state, and perfectly insulated, with the metallic contact unbroken, I do not show the slightest deflection; but if the metallic contact continues perfect, and the insulation becomes imperfect, I am then in a diseased state, and the virulence of my disorder is in proportion to the number of degrees of deflection shown by the galvanometer. When the ELECTRICIAN felt my pulse and applied his tests, to ascertain my state, he found that I exhibited symptoms of the most fearful character, and that his instruments denoted my disorder was so serious as to give nearly seventy degrees of deflection. Struggling against facts, and hoping against hope, he thought it possible still to restore me, and in the belief that the seat of my complaint was only a few miles off, he attempted to reach it, with the intention of subjecting this part of me to a surgical operation, in the vain anticipation that by so doing he might ultimately restore me to health. Nothing, however, could have saved me, for as I have already stated, I was diseased in every part of me, and I died from general debility. His intentions were good, and I, at least, am grateful to him, though it appears his attention to me was not palatable to the other officials—possibly they thought it was a reflection upon them, who left me at my dying moments, to grasp at empty honours ere I died. But the worst feature in this part of my unfortunate life is the reprehensible attempt made by some injudicious friends of these gentlemen, to induce the nation to commit itself to a solemn mockery, and suggesting that a day of public holiday should be set apart for the celebration of their imaginary success.—*C. West.*

Recent Patents.

1255. J. CLIFF, *Lambeth, Surrey*, "*Insulators for supporting telegraph wires.*"—*Dated* 29 *April*, 1862.

THIS invention consists in constructing what the inventor terms a compound insulator. The compound insulator consists of two parts; the outer part is formed with a notch in the top for the reception of the telegraph wire; the other part consists of a shaft, carrying near the bottom thereof a disc, the diameter of which is nearly equal to that of the inside of the mouth of the outer part. The bottom of the shaft has a hole formed in it for the reception of the pin, or stud, by which it is connected to the post, or other support. The head of the shaft is intended to be lodged in a recess formed in the inner and lower part of the body of the outer part, in order that the two parts may be united to form the compound insulator, by means of sulphur, or other suitable insulating cement. Care must be taken that the shaft and upper part shall in no part be in contact, therefore the size of the recess must be large compared with the size of the head of the shaft. In order to prevent wet or moisture injuriously affecting the insulator, the inventor applies a coating of shellac into the upper angle or head inside the outer part. The recess into which the head of the shaft is inserted is enlarged at the bottom, and for further security against damp or wet affecting the insulator, the inner surface of the bottom part may be coated with shellac, or the space between it and the spindle may be filled with that material.—*Not proceeded with.*

1268. G. DAVIES, *Searle-street, Lincoln's-inn-fields, London*, "*Electric Apparatus.*"—*A communication.*—*Dated* 30*th April*, 1862.

THIS invention consists in the application of electric apparatus or gearing to various useful purposes. First, to the working of breaks, signals, and other apparatus on railways. Secondly, to feeding steam boilers, and to water gauges, pressure gauges, and safety-valves. Thirdly, to regulating the temperature of gas, and of hot or cold air, and fluids in general. These results are obtained by the action of an electric pile with optional intermittent contact acting either manually or automatically upon appropriate gearing or apparatus.

1304. A. V. NEWTON, *Chancery-lane, London*, "*Improved Electrical Apparatus, applicable to the lighting of gas.*"—*A communication.*—*Dated* 2*nd May*, 1862.

THIS invention cannot be described without reference to the drawings.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—Every one will hail with feelings of unqualified satisfaction the announcement of the forthcoming Extraordinary Meeting of the Shareholders of the Atlantic Telegraph Company. It is, at least, an earnest that this question, which is uppermost in all men's minds, telegraphic communication between the two hemispheres, is in a fair way towards receiving a practical solution. And truly now the three continents Europe, Asia, and Africa, are, to a certain extent, united by the electrical bond, and the time by no means remote when their most distant and isolated regions, will throb in unison with the great centres of civilized pulsation; there is felt to be the main link wanting in the chain, so long as America is dissevered from the Old World. At intervals, ever and anon, the impatience on this head unmistakably manifests itself, indicating the enduring interest in it, which pervades all classes; and indicating also that this impatience evinces a degree of irritation and annoyance, first, that the original attempt should have failed through manifest bungling, and other causes that will bear still stronger epithets; and again, that the second attempt should be so long and so unnecessarily delayed, seeing that the skill, energy, perseverance, and every other quality required would be found forthcoming, if parties would step forward to promote the object in whom every one could place trust and confidence, men, in short, which all such occasions require, like Stephenson and Brunel, and others, giants in practical intellect, who, having successfully overcome the most formidable of nature's difficulties, have left their "footprints on the sands of time" for our guidance. When the embryonic idea of any great project first assumed a definite shape in the recesses of their own souls, these men could grasp them in their entirety, could take in the whole from beginning to end, see their way clearly through all obstacles, and feel their own competency to consummate to perfection their most stupendous works; hence they were uniformly successful in all their engineering projects, and their name and fame are engraved in eternal characters of the landmarks of civilization. We sadly want such men to carry out the grand idea of submarine telegraph. Men with manliness enough in them to set at nought petty interests, antiquated notions, and every other contemptible trifle that obstructs their path, with as little ceremony as they would natural difficulties, being conscious to its fullest extent that they are indeed lords of the creation, before whom the superannuated pottering tinkerers must give way in virtue of their kingship.

Doubtless such men are to be found, but, like all kingly natures, the Nazareth whence they shall arise, will probably be such as to make the delicate nostrils of self-constituted scientific greatness sniff in supreme disgust. They will come, nevertheless, no mere talkers but doers, not theorizers but practical men with long heads, who shall take in at one comprehensive grasp all the difficulties of the perfect manufacture, and submergence of any length of submarine cable, and be prepared with the antidotes, which shall nullify impending defeat.

The man is always forthcoming when the occasion requires, but the world is invariably so obtuse, or wise in its own conceit, from interested motives, or from offendid dignity, as to run counter, unwittingly, of the very thing of which it is in pursuit, and it is not until they have stumbled times without number, bruised their shins, and eaten a considerable quantity of humble pie, that they at length open their stolid eyes and confess what fools they have been. But the force of circumstances will eventually thrust the man upon the occasion, which in the eternal fitness of things he, and he only, was created to successfully cope with, and it is well for that nation, or that community, or that company, whose eyes are open to observe that, which generally, everybody else can see but themselves. We dare not be over sanguine, that the Atlantic Telegraph Company have attained to this clearness of vision, we can only hope they are on the right road for it. Sooth to say, their eyes should have been opened by this time, as wisdom, purchased by such experience as theirs, is supposed to have that effect: but if we are to judge by the style of cable again proposed, together with the letters which we sometimes see from electrical and other big-wigs addressed to this company, we are driven to the opposite conclusion, or else the writers of the said epistles assume unjustly, that, in this particular instance, experience has not borne its legitimate fruit. And I dare say they are right, for it must be borne

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in mind as a remarkable fact, and one that tends considerably to dissipate contrary hopes, that the ponderous cable proposed for the second attempt, considerably more weighty than the first, was not peremptorily rejected, as the fatal rock on which their fortunes had once foundered, but, on the contrary, when its description appeared in print, was accompanied by the unmistakeable commendations of the company, which only a lack of funds prevented them from unhesitatingly adopting.

If experience is thus to be lost upon them, we certainly must give up their case as hopeless, although it may possibly be partially redeemed by a temporary success, and look to a new company to connect the Old World and the New, which of necessity involves a new route; and doubtless the one via Labrador and Greenland is after all *the one* which will first become a practical, lasting, and efficient reality.

We may surely be allowed to speculate how far the remarkable unanimity of all nautical men as to the superiority of cables of a light specific gravity for deep seas, has influenced the shareholders of the Atlantic Telegraph Company. Is their preaching, like that of so many others of your correspondents, whose notions are in advance of the times, thrown away in this case also? And does this company, whose destiny as it were trembles in the balance, place more confidence in men who have scarcely smelt salt water than in any number of admirals, commanders, captains, mates, and super-cargoes? I am sadly afraid they do; but a few days will probably reveal to us whether they mean still to stick to the flesh pots of Egypt on which they have grown so fat. The catalogue of objections against the use of a heavy iron sheathed cable is a long one, but need not be written down here, surely every one has it by heart, and the repetition might become wearisome to those whose prejudices are deeply rooted. "None are so blind as those who will not see." Of the various styles of light cables there is not one but would be superior to the cumbersome ones now in vogue whose excessive strength is their great weakness. Mr. Duncan's Ratan Cable would be infinitely preferable, although personally I have no very high opinion of spiral formed cables of whatever material composed. One might almost imagine that that prince of engineers, Robt. Stephenson, was gifted with instinctive perception and prescience, when he gave it as his opinion that a hempen covering was the best, both for strength and durability. An opinion from such a quarter should carry weight, and, combined with the nautical testimony above referred to, should certainly have some influence even on an Atlantic Telegraph Company. Now there are various styles of Hempen Covered Cables patented, some of which are peculiarly adapted for deep seas. A regard for your valuable space will only admit of my making reference to one, that of Hall and Wells's. Its longitudinal strand must of necessity prevent elongation, and add enormously to its strength, while the novel method of braiding over the whole with the same material renders it compact, and proof against the widening of any aperture that may exist in the braided film; and this cable could be increased 1 inch or more total diameter, without adding materially to its weight.

Of course, it is hardly to be expected that the Atlantic Telegraph Company will listen to the suggestion of caoutchouc as the insulating material for their next cable, notwithstanding it is the best insulator, and, moreover, backed by the recommendation of the Government Report; and need I urge, that true economy insists upon the best of material and workmanship in order to ensure success in an undertaking of any importance.

I am not over-sanguine as to the results of the present movement; but I trust, for the sake of the world's advancement, and our own credit as a nation of painstaking and practical men, that we shall rather err on the side of over-scrupulousness, than by a persisted adherence to old-fashioned, if not exploded notions, risk the inscription of a second Atlantic Cable failure in our historic records.

Perhaps I may be allowed a few words with reference to the advertisement convening the meeting to take place on the 12th inst. Evidently, those who got it up were impressed with the necessity of making the most of things, in order, doubtless, to stimulate the shareholders to the required degree for operating financially; but it is a pity truth was not adhered to, and gross misrepresentation avoided. I would fain believe that it arose from inadvertency; but whether it be so or not, it is incumbent upon me to deny that the Toulon and Algiers Cable (now defunct for a time) was ever worked at the uniform rate of eighteen words per minute; and as to the Malta and Alexandria Cable, which is represented as "working at a much higher rate," it is a notorious fact, which I have upon the authority of one of our most eminent telegraph engineers, that the utmost working speed is from *three to four words per minute*. I leave this fact to speak for itself; it requires no comment, and should certainly put the shareholders of the Atlantic Telegraph Company on their guard.

Notwithstanding the disastrous results which have attended gutta percha insulated cables in tropical climes, and in localities, too, where the temperature is not extraordinarily high, the Indian Council have decided upon, and ordered a gutta percha core for the Persian Gulf Cable. I satisfy myself, for the present, by simply announcing the startling fact, and propose to comment thereupon in your next number.—

M.

ANTI-GARROTTERS.

To the Editor of The Electrician.

Sir,—Although your journal does not profess to keep its readers informed of the stirring incidents of the day, unless they are connected with electric or chemical science, yet I may plead for space to enquire whether your correspondent "Philanthropos," cannot inform us of some invention of the same nature as he speaks of, as being capable of application to refractory horses, which might serve as a protection to the public against the garrotters, and which might be worn round the neck in such a way as to administer a powerful electric shock to any one who laid their hands upon one's collar, and possibly, compel them to remain in that position until he had called for help, and were prepared to release them for the purpose of giving them into custody. If not, as there is a new and wonderful discovery for applying electricity without the intervening medium of wires, perhaps you could apply such a shock to Sir George Grey or Sir Richard Mayne, as would stimulate them to take action in the matter, and awake out of their apparent lethargy to a full conscientiousness that respectable heads of families, like myself, are harrassed by daily and hourly anxieties, which are to a great extent participated in by our lovely spouses at home, in case we happen, by any pressure of business, to be detained in the City longer than usual, from our customary hour of arriving at our homes, in time to make leisurely preparations for our prandial comforts.

In passing along Newgate Street to day, I observed portions of the *Daily Telegraph* Newspaper, containing *the Sensation Articles* upon this all exciting subject, attached to a window, were formidable knives with spring backs and dagger shaped handles were exhibited, with the announcement that fire arms being of no use, nothing but the knife remained to us as a protection. I assure you, Mr. Editor, that it made my blood run cold at the suggestion, and as I am a highly nervous man, and a firm disciple of the peace party, I do hope, for the credit of this the *enlightened nineteenth century*, that something will be done speedily and humanely to guarantee the public safety. Even the cabmen make capital of the excitement, and as I was leaving Church on Sunday evening, assured me that I had *better take a cab*, as it was *dangerous to walk home* at night.—I am, sir, yours obediently. Paterfamilias.

London, 3rd *December*, 1862.

THE WALKER COLLIERY EXPLOSIONS.

To the Editor of The Electrician.

Sir,—A letter in the *Times* newspaper of to-day, signed "Y," having attracted my attention, I should be glad, Mr. Editor, to call your attention to the subject, that, in the interests of humanity, you might be the means of averting some of those dreadful calamities in mines, of which, unhappily, we too frequently become aware. I feel certain, from the acknowledged eminence in which your scientific knowledge is unquestionably placed, that, if you would make the subject an especial study, and place it before your readers in your usual clear and lucid style, much practical information might be placed within the reach of those who have the charge of mining labourers and their workings, that, at present they must be greatly in need of. The correspondent of the *Times*, "Y," seems to consider that the proper verdict of the jury should have been, "*Explosion, of which the cause is unknown.* He suggests to inventors the desirability of some means of removing the carbonic acid gas from that quantity of oxygen which is left after a colliery explosion has taken place, so as to enable the survivors to support life until assistance arrives; as he says, great destruction of life frequently arises from the after damp. He also comments upon the unsatisfactory conclusions of another correspondent of the *Times*, dated the 1st of November and the 5th of December, upon the subject of Will-o'-the-wisp or ignited marsh-gas (carburetted hydrogen). It is quite evident that these good gentlemen are confessedly wandering in the dark, and if you could spare the time to hold before them the light of science, you would be rendering a most valuable service to your fellow creatures, and further the object of your constant reader, Philanthropos.

December 5th, 1862.

To the Editor of The Electrician.

Sir,—As we live in days when the value of time is so highly appreciated, and all, from the highest to the lowest, are working at high pressure, I think I shall not be out of place if I seek a space in your journal for the purpose of suggesting that the Bishop of London might be enabled to keep pace with the times, if an electric telegraph were laid on to St. Paul's Cathedral and put in communication with every vestry room in his diocese, so that he might then believe that the words of loving kindness and carefully-considered advice, which he is supposed to be able to address to every one of the souls committed to his charge, through their respective pastors and teachers, might reach their destinations without taking away, from their several spheres of usefulness, those active and hard-working gentlemen who cannot afford the time to remain during the whole of his address to them in St. Paul's Cathedral. I cannot imagine that men with the education of gentlemen, much more clergymen, can be so wanting in courtesy as to leave their brother clergymen and bishop's presence whilst he is addressing them in a tone and spirit of Christian courtesy, unless they have urgent private affairs that compel them to leave for their own parishes, in order that they may carry on more diligently their labour of charity and love, which we give them credit for the due performance of. As it is impossible for a bishop, personally, to visit every clergyman

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in his diocese in the course of the year, and as a printed charge might remain unread, and, unlike sermons in general, is open to hostile criticism, the desired ends might be obtained without showing a bad example to the laity, in the way that the correspondent of the *Times*, "One who stayed," speaks of in his sensible and well-timed letter of 6th December, headed, "*Bishops, Clergy, and Congregations.*"

As I am a constant reader of your journal I hope that your clerical readers, who, like myself, consider science an handmaid to religion, will take the matter into consideration, and reform the existing defects.—I am, sir, yours obediently, Ecclesiasticus.

London, December 8th, 1862.

[Our correspondent does not appear to have considered whether his suggestion is practicable; or whether it would be acted upon. If, however, he will consult his brother churchmen upon the latter point, we might perhaps do something to forward the project.—Ed. E.]

To the Editor of The Electrician.

Sir,—Is there any practical method of absorbing the nitrous acid given off from the cells of a Bunsen's battery? will lime be of any use? it has been suggested, but I am afraid will not be effectual.—Yours very truly,

J. C. Janson.

Darlington, December 6th, 1862.

To the Editor of The Electrician.

Sir,—Would you be kind enough to ask Mr. W. H. Monney, of Dublin, where his break is on his induction coil, and if it is worked by a separate magnet, and how much per pound the fine silk-covered No. 35 wire costs, and so greatly oblige W. N. B.

New Northallerton, December 6th, 1862.

To the Editor of The Electrician.

Sir,—Will you permit me, through your columns, to ask any of your electroplating readers if they will kindly give me the information requisite to produce the rich tint now so universal on electro-gilded articles, and also how the frosted silver may be obtained a snow white, and not tinged with yellow.—Believe me, yours, &c. H. M. H.

8, *Royal Parade, Blackheath.*

Telegraphic News.

Telegraph to British Columbia.—Mr. George Grenfell Glyn, M.P. Mr. Watkin, Mr. Robert Benson, Mr. Newmarch, F.R.S., Mr. H. Wollaston Blake, and Capt. Glyn, R.N., have had an interview, at the Hudson's Bay House, with the Governor and Court of the Company, with reference to the establishment of telegraphic and postal communication across British North America to British Columbia and the Pacific, the conference having been suggested in a communication from the Colonial-office.

The Bombay Government has brought before the Government of India the urgent necessity which exists for a branch line of electric telegraph, diverging from the main line near Dharwar, and connecting it with the new port of Sedasheghur, and other important trading towns, in the district of North Canara. The local government has represented the great desirableness of having this branch line completed, and ready for use, by the time the cotton crop of the coming season would be ready for conveyance down the ghats for shipment at Sedasheghur.

The following letter, relating to irregularities in the management of the telegraphic communication between Lisbon and London, appeared in the *Times* of the 9th inst:—

"150, Leadenhall-street, Dec. 5.

"Sir,—The enclosed telegram was sent from Lisbon on the 29th ult., and reached us this afternoon, the time occupied in its transmission being nearly *six* days.

"The object of the message was to anticipate the news by the Brazil steamer, but the latter arrived yesterday morning.

"Your publication of these facts may probably tend to remedy the inexplicable delays which are constantly occurring in the transmission of telegraphic messages from Lisbon to England.

"We are, Sir, your obedient servants,

"ANTONIO RIVOLTA AND SONS."

The report of the Telegraph to India Company (limited), preparatory to the meeting on the 12th inst., has been published. The communication between Alexandria and Jubal is maintained, and is worked at a profit which will leave a satisfactory return upon the money invested. As the Government propose themselves to construct the line in the Persian Gulf, the directors have considered it necessary to convene the shareholders to lay the whole case before them. The traffic in the portion open is expected to increase, and, at present, will pay £5 10s. 8d. per cent. on the subscribed capital of £45,175. The property, in the shape of new cable, and other things at the various stations on the Red Sea, will be realised for the benefit of the undertaking.

TELEGRAPHY IN COCHIN CHINA.

In Cochin China, a telegraphic line has been established by the French, from Segon to Ton-Keon, which is stated to be already well employed. Another line has been constructed from Segon to Tranbou, and it is stated that, when the dry season sets in, telegraphic communication is to be further extended.

Miscellanea.

A communication from Toulon, in the *Messager du Midi*, says:—"The laying up of the frigate *La Gloire*, in the Gastignean dock, has disclosed three unexpected phenomena; the first, that the contact of the copper lining and the submerged iron plates had established a galvanic current, which produced the effects of a voltaic pile, and was completely deteriorating the armour of the frigate in the parts below the water line; secondly, that a species of shell fish, hitherto unknown, was afterwards discovered among the millions of molluscæ, by which the hull was covered, apparently produced under the influence of the same galvanic current; and, lastly, in the hold of the vessel 22,000 litres of wine were found to be transformed into vinegar, it is not known by what influence.

Iron Exhaled by Plants.—In an elaborate memoir recently presented to the Academy of Science at Paris, M. Kosmann gives an account of a series of experiments in regard to this subject, carried on at his own house in the middle of Strasburg—the botanic garden of that city—and in a spacious garden above thirty miles from it—these three places seeming to offer the differences which should characterize vegetation in the midst of towns, and that of the country, in various degrees. He made use of Schönbein's ozonometic scale, and ozonoscopic bands, fixed on the plants. For details we must refer to the *Comptes Rendus* for Nov. 10, last. The following are given as the results of his observations from July 29 to September 14 of this year:—1. Plants give of ozonised oxygen from the midst of their leaves, and other green portions. 2. Their leaves give off during the day ozonised oxygen in measurable quantity, much greater than that which exists in the surrounding air. 3. During the night the ozone disappears where vegetables are sown sparingly; but where there is an accumulation of plants growing with vigour, the proportion of ozone immediately about the plants is greater than that in the external atmosphere. This may be explained by supposing that the ozone evolved during the day continues to surround the plant at night when the weather is calm. 4. Plants in the country give off more ozone than those in town. 5. Hence we may infer that the air of the country, and that of habitations surrounded by vast forests, gardens, &c., is more vivifying than that of towns. 6. In the midst of towns and a concentrated population the ozone of the air at night is more considerable than during the day. If we go away a little from the concentration of men, and enter into that of plants, the excess of the ozone in the night, above that in the day, diminishes; and if we advance further into the country, where plants are more numerous than men, the ozone during the day becomes more considerable than that at night. 7. The interior of the corollas gives off no ozonised oxygen. 8. In dwelling houses oxygen does not generally exist in the ozonised form. The experiments of M. Kosmann will be resumed in the spring.

To Correspondents.

A. H. B., Clapton.—The diagrams may be obtained of Messrs. Sandford, in the Strand, or of Messrs. Darton, Holborn Hill. Several of our telegraphic instrument manufactnrers would, we have no doubt, furnish the instruments. We shall be glad of an abstract of the lecture.

H. Walters.—Professor Wheatstone and Mr. W. T. Henley, have lately furnished a considerable number of instruments to the Australian Colonies. Probably either of these gentlemen would be able to furnish you with the desired information. A practical knowledge of the construction of their dial instruments would be desirable.

Citizen.—Too late for this week.

Errata.—Mr. W. H. Monney, whose valuable letter on the induction coil appeared last week, points out that several of the paragraphs in the latter portion of his communication have been transposed. This information will enable our readers to follow the letter consecutively, as the transpositions are sufficiently obvious.

In the last No., p. 50, £200 was given as the cost of a form of cable proposed for the Atlantic line. For £200 read £300.

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The Electrician.

VOL. III. No. 59.—DECEMBER 19, 1862.

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THE ATLANTIC TELEGRAPH.

ONCE more the important project of the Atlantic Telegraph Company is fairly before the public. In almost every quarter the Company may command sympathy and good will in their continued endeavours to realise the splendid problem of the nineteenth century; we trust also, and fully expect, that they will command ready and adequate support. Without being influenced by a very natural but possibly dangerous enthusiasm in favour of such an undertaking, we may confidently express the conviction that, simply as a question of applied science, the laying of an efficient and permanent conductor across the Atlantic is not only feasible, but safely practicable. In regard to the no less essential point of commercial practicability, there appear to be very reasonable grounds for arriving at an equally favourable conclusion. Indeed, in this particular case, the scientific aspect of the question necessarily involves the character of the undertaking in a commercial point of view; the guaranteed minimum of 8 per cent. *being contingent upon the successful working of the cable.* There is little doubt that this fact will be duly appreciated, and will operate as the most powerful inducement for the adoption of the best means of insuring success, irrespective of every other consideration.

It may be necessary, therefore, that we should point out that much remains to be done before the unreserved confidence of the public can be obtained upon secure premises. Nothing very definite has yet been stated in regard to the principles upon which the renewed endeavours of the Company to establish a trans-Atlantic communication are to be based. We observe with satisfaction that the distinguished names of Professors WHEATSTONE and W. THOMSON, and of Dr. FAIRBAIRN, have been connected with the undertaking in the capacity of honorary scientific Directors; but we are by no means certain that the services of these gentlemen will be brought into practical requisition. Indeed, the nature of the cable which is to be laid appears to have been already virtually determined, although it has not yet been specified, and is, therefore, beyond the reach of examination or criticism. It needs but a very superficial analysis of the statements which have been put forward by the Chairman of the Company, and of the published remarks of their electrician and engineer, to arrive with tolerable certainty at the conclusions that, in the first place, the contract for the manufacture of the cable has, in anticipation, been granted to Messrs. GLASS and ELLIOTT; and secondly, that the wire will be insulated with gutta percha. Neither does it require any unusual degree of acumen to predict that the core will, almost inevitably, be sheathed with spiral iron, or steel, wires. If, in fact, the contractors are allowed to embark £25,000 of their own cash in the new capital, and "to undertake all the responsibility of laying down the cable, as well as of constructing it", it is but reasonable to suppose that they will also be allowed to adopt the means which in their estimation are best adapted to secure the efficiency of the cable. The nature of these means is not open to much doubt, and may probably be inferred from that portion of Mr. WORTLEY's address in which the Toulon and Algiers cable was alluded to.

It is difficult to conceive upon what points the counsel of the scientific committee, "assisted by Mr. Varley," can be adopted; and the position of the gentlemen constituting this committee appears therefore somewhat anomalous, if not derogatory. If we suppose their functions to be otherwise than nominal, and their appointment to be something more than a matter of public policy, involving merely a partial risk of scientific reputation, we cannot but think that these may possibly prove prejudicial to the present prospective arrangements of the Company. Let us imagine, for instance, that Professor WHEATSTONE, acting upon the conclusions arrived at by the Government Committee, should recommend a different insulating material to that of which the advantages have recently been so strongly, though somewhat one-sidedly, advocated by Mr. C. F. VARLEY. Or, again, let us suppose that Dr. FAIRBAIRN, adopting, upon grounds of his own, the opinion of ROBERT STEPHENSON with reference to cables intended for deep seas, was to suggest one of a specific gravity but little greater than that of water. It will be allowed, we think, that in either of these cases, which are by no means absurdly hypothetical, some inconvenience, if not *inconvenance*, might result from the appointment, under the circumstances referred to, of the scientific committee.

To resume, however. Though much has been done in the way of diplomacy, though influential interests have been reconciled, and mutual support conciliated, at what may be considered a trifling sacrifice of independence, the essential questions of what is most expedient in a scientific point of view, are left almost untouched. What we most require to know, on behalf of the public for which we write, is whether any definite plan of construction, embodying the results of past experience and recent improvement, is in contemplation for the second Atlantic cable. Upon this, far more than upon any measures of popular policy, is dependent the proximate and ultimate success of the present endeavours. The confidence of the public in the practicability of such undertakings "has increased, is increasing, and should be further increased;" but it must be based on something more definite than the "mutual congratulations" of those who are more immediately concerned in forwarding them. To us, the most important announcement made by Mr. STUART WORTLEY, is that in which he expressed his conviction that "the lightest cable was the one most likely to succeed"; a principle which, notably in the unfortunate allusions to the Algiers cable, appears to have been lost sight of in some portions of the address. We sincerely hope that neither this cable, nor the more expensive and cumbrous one of which specimens have recently been exhibited, and which is said to have received the approval of the Company, will be adopted as a model for the newAtlantic line.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY, BY THE SUPPRESSION OF RETARDING INDUCTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 61.)

SUPPOSING every particle of common matter to have the whole of its electrical equivalent collected around it in a quiescent condition, conferring upon it its several chemical affinities each relative to some other particle of common matter surrounded by its particular equivalent; supposing that no particle of electricity had been removed, by any means, from its position of natural relationship into another position, thereby becoming itself a plus electrical charge, and occasioning, by its absence, a minus one, thus initiating, in two places simultaneously, the inductive action we have been tracing from the definite nature of the electrical attraction,—still that attraction, under the normal state of electrical distribution would, on the common principles of mechanical philosophy, be at work in two opposite directions, namely, in each

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particle of common matter towards its equivalent of electricity, and in the electricity towards its equivalent of common matter. The same reciprocity must also exist under induction, but the field of action, or direction, will be changed; for whether common matter be attracting its own electricity, or other foreign to it, the attraction must pass in a right line between the points of action. Now in all cases of induction, it is the attraction of the common matter for any part of its electrical equivalent that may have been separated from it to an abnormal distance that was represented by the *resinous* electricity, or *negative* force of the older systems; and the attraction of electricity for the common matter to which it belongs that the name of *vitreous* electricity, or *positive* force, was given. We can easily understand now how it has been that the vitreous and the resinous electricities, or the positive or negative forces, never appeared one without the other, and also why, in all cases, they have been equal. If simplicity be a recommendation, it cannot be a question which of the views of electrical action will best thus recommend itself, and simplicity ought to be received as a test of truth, when, as in the present instance, it is accompanied with by far the greatest amount of efficiency.

When, in the *Philosophical Magazine* for 1838, I had the good fortune first to suggest the definite nature of the electrical attraction, I had occasion to dwell upon the obvious fact, which now will have an important bearing upon our subject, namely, that the power with which common matter retains its equivalent of electricity, is antagonistic to that by which the same electricity may be liberated from it by induction, both powers being due to the same electrical attraction. It would be quite in accordance with practice in the mechanical sciences to speak of the liberating and the retaining powers as *antagonistic forces;* but I shall refrain from such expressions, as the best way to avoid leading the student of electricity to imagine he is dealing with two distinct forces, different in their natures, while the difference is one merely of direction. We shall easily bear in mind that the retaining electrical attraction is interchanged between common matter and its own natural electricity, and that the liberating power of the same attraction acts between the common matter and the inducting electricity, or, when minus, common matter is acting inductively between that matter and the natural electricity of the body, subject to the induction.

The first thing we need to be sure of is, the law of electrical quantity; that is to say, how the electrical attraction varies with the quantity of electricity acting upon a given portion of common matter; because that must be the law of induction, and of the antagonism opposed to it. Now attraction, practically, if we believe what we see, varies as the square of the quantity in operation, and I make theory conform to the requirements of observation, against which, as I have before shown, there is to be raised no valid philosophical objection.* In every case in which the experiment has been tried, a double quantity of electricity has acted with a quadrupled force, treble the quantity has made the force nine times as great, and so on with higher numbers; and without that ratio, or some other differing from simple proportion, induction would be a thing unknown. It is of the utmost importance for this to be perfectly understood, and we may easily understand it. Without caring to define the exact law of electrical attraction as influenced by distance, we can of course affirm, with respect to it, that the force becomes greater is *some* inverse ratio of the distances, for, unless it did so, it would not be attraction. Now, supposing we had on some body electricity accumulated in quantity beyond what was natural to it; it would be to that body a plus charge, and would act by induction on any insulating conducting matter that might be around it; but no surrounding matter could be nearer to it than to its own natural electricity, notwithstanding, which it will, as we practically know, cease to attract its own electricity, in order to attract the plus charge. Now, this it obviously could not do unless the antagonism opposed to the inductive action, that is, the retaining power, were inferior to the induction itself.

Since the induction is not brought about by a greater proximity, on what mechanical principle can it be accounted for? How is the liberating attraction to be made superior to the retaining attraction? We find the answers to these questions in facts read in the light thrown upon them by the electrical law of quantity. We may, of course, imagine we have a plus electrical charge; but, in reality, we cannot cause one to collect unless its induction, when collected, can be more widely distributed than it is actually in the position from which it would have to move; the increased distribution being made efficacious by the fact of its allotting more common matter to sustain the induction of a given quantity of electricity, the antagonism opposed to induction always varying as the square of the quantity of electricity acting upon any given body. The retaining power of attraction diminishes in the insulator around a point or a line in a very rapid ratio of the distance, as explained in the ELECTRICIAN, Vol. i. No. 17. It may suffice here to remark, that it follows from the electrical law of quantity, that when the induction of a given plus accumulation is distributed successively over a double, a treble, and a quadruple quantity of common matter, that the antagonism opposed to it becomes reduced to one-half, one-third, and one-fourth, respectively; because $\frac{1}{4}$ the power $\times 2$, the distribution $= \frac{1}{2}$; $\frac{1}{9}$th the power $\times 3$, the distribution $= \frac{1}{3}$; $\frac{1}{16}$th the power $\times 4$, the distribution $= \frac{1}{4}$: a rate of reduction that is powerfully effective in promoting the distribution of induction whenever opportunity is afforded for its falling upon increased quantities of common matter.

If we steadily keep before our minds the nature and operation of induction as thus depicted, we shall meet with no difficulty in comprehending the functions of the electric telegraph. We have been long accustomed to impute mysterious powers to the voltaic apparatus, I think needlessly; but I must be content to leave its performance a mystery, until I shall have opportunity to come back upon it. In the mean time, the principles of electrical action with which we are at present engaged, make it clear, and that is enough for our present purpose, that electricity, whether it have been accumulated in excess upon a conductor from a voltaic or any other source, tends to distribute itself, in order to act by induction against lower powers of antagonising attraction. Now, the power by which that distribution must be accomplished may be called *motive tension*, and it will obviously vary directly as the difference between two antagonisms opposed to induction, namely, that which, under existing circumstances, *is* opposed to it, and that which, in consequence of the increased distribution, is *to be* opposed to it. Motive tension, as thus defined, may be exactly calculated; for example, let an existing power of antagonism or intensity of electrical action be 20, and the antagonism under some new possible distribution 15; then the motive tension will be 5. Again: suppose the existing intensity of the retaining powers to be 20, and that the accumulated electricity be offered an increased distribution, under which its intensity may become 0; the motive tension impelling the electricity to move into the new position will be 20; or make the present intensity plus 20, and offer the electricity conducting communications to an equivalent of common matter whose electrical condition is minus 20; the motive tension will then be $20 \times 20 = 40$.

Motive tension thus calculated will not be the same thing as intensity of induction, but a difference between two such intensities, if both be either plus or minus; or the sum of two intensities, if one of them be plus and the other minus.

We have already obtained from the definite character of the electrical attraction a static induction to set free in common matter a portion of its natural quantity of electricity; an internal retaining power in common matter to antagonise with the external induction; and a difference of intensities, both of induction and antagonism, for propelling the liberated electricity

* See ELECTRICIAN, Vol. i. No. 16. Also Matter and Force, by the Author, published by TAYLOR and FRANCIS, Red Lion Court.

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into motion, and of which I shall hereafter speak as *motive tension*. It now devolves upon me to point out a most important difference between the functions performed by motive tension and inductive intensity; it is this: while the former governs the *velocity* of electricity in motion from a state of lesser to one of greater distribution, the latter determines the *quantity* that can simultaneously move through a given conducting communication; they are, therefore, not to be confounded with each other, although it will often happen that they are equal. To illustrate the function of inductive intensity in determining the capacity of a conductor, suppose that the plus electricity, acting simultaneously in any section of a wire, were to be successively doubled and trebled; according to the law of electrical attraction, the intensity of induction will thereby be made four times and nine times as great; but as the same law demands that the corresponding quantities to be liberated from each particle of the conducting matter shall be retained with forces increasing in the same ratio, the action of the conducting line will be simply doubled and trebled when the quantities of electricity acting by induction are so.

I have elsewhere shown the claim of electricity to the general properties of matter by publicly suspending it to the scale-beam, under circumstances pronounced by recognised electrical authorities to be unexceptionable, and thus experimentally proving its ponderability. To that demonstration no objection has ever been suggested; and its not being yet publicly admitted, I attribute to the little pains I have taken to make it generally known. The innovation is perhaps too violent and unexpected. I allude to the circumstance in this place because telegraphists have found it necessary to assume, and electricians have admitted, at least tacitly, their assumption, that the motion of electricity is subject to some resistance, thus bringing it under the dominion of universal mechanical principles. To be consistent, we must admit that the resistance is experienced every time that the motion of electricity commences; and if there be any reality in Faraday's discovery of contiguous induction, or truth in the doctrine of definite electrical attraction, electricity, while passing through a line of conducting particles, must begin to move as many times as there are particles for it to be arrested by. Whether we choose to call that resistance *inertia*, or to leave its nature undefined, matters not. We must equally adopt the conclusion, that it will vary with the quantity of electricity, and the number of times it is put into motion, that is, as the length of the conductor it is propagated through.

Such are the leading principles flowing from the definite nature of electrical attraction, and involved in the performance of the electro-telegraph. We may next ascertain what they will do for us.

TELEGRAPH TO INDIA COMPANY (LIMITED).

A SPECIAL General Meeting of the Shareholders was held on Friday at the London Tavern, Bishopsgate Street, for the purpose of receiving and considering a report of the Directors on the present position of the Company's affairs, Sir Macdonald Stephenson in the chair. The Secretary having read the advertisement convening the meeting, the report, of which we give an abstract, was taken as read:—"The shareholders will doubtless recollect that when the first ordinary general meeting of the Company was held, in July last, the Board had received an intimation of the intention of the Indian Government to undertake the construction of the line of telegraph from Bagdad to Kurrachee, and that, in consequence, the Directors recommended that no steps should be taken beyond keeping open the communication between Alexandria and Jubal, until they had ascertained the views of the Government in relation to the line in the Persian Gulf. The shareholders were at the same time informed that a communication had been addressed to the Secretary of State for India, in which the claims of the Company to be entrusted with the proposed work were brought under his notice. The correspondence, a copy of which is annexed to this report, resulted in the decision of the Secretary of State for India in Council, that the Bagdad and Kurrachee line should be constructed by the Government of India. The line between Alexandria and Jubal continues to work most satisfactorily, and a return of the weekly traffic, since the opening of the line, shows that the Company's receipts have reached an average of about £170 a-week, or at the rate of nearly £9000 a year. The annual expenditure, on the lowest scale consistent with efficient working, is estimated at £6500 per annum, including all expenses at home and abroad; but this amount will be considerably reduced should the Government agree to a proposal made to them by the Board, to allow the telegraph offices in India to receive messages for the Company, which will obviate the necessity of maintaining agencies abroad. Thus it will be seen that, should the present receipts only be maintained, a balance of profit will be left equal to £5 10s. 8d. per cent. on the subscribed capital of £45,175. The traffic, however, appears to be steadily increasing, and the Directors have every reason to believe that it would be extended considerably if messages could be transmitted in the Arabic language. With a view of trying that experiment, they have authorised their superintendent to engage three or four native signallers at trifling salaries. It is also proposed, at the request of some of the leading merchants in Alexandria, to open a station at the large native town of Tanta, through which the line passes, and where a considerable amount of business is expected, especially in connection with the cotton trade. Under these circumstances, there appears no reason for abandoning the undertaking, which is even now remunerative, and which, there is every reason to believe, will become increasingly so, while the possession of the line from Alexandria to Jubal gives the Company the key of the work, if ever it be found expedient to carry it on to Aden or India. The Directors therefore recommend the Company to continue to work the land line in Egypt and the cable between Suez and Jubal, retaining the firmans, instruments, and other property in Egypt; as, in the event of the Bagdad line proving inadequate to the commercial requirements, or from any other cause which shall indicate the need of an alternative means of communication, the Company would no doubt receive the cordial support of her Majesty's Government and of the public in continuing the line. Should the shareholders concur in this view, the Board would further recommend that the land line in Egypt, which must, at all times, be a property of considerable value, should be placed in a state of thorough and permanent efficiency, and for this purpose it is advisable that the whole of the posts should be carefully examined and renewed where necessary, and, moreover, that a portion of the line, where it diverges for a considerable distance from the railway, should be removed to the line, the difficulty and expenses of supervision at that point being now very great. The whole cost of a thorough inspection and renewal of the posts, including the removal to the railway, will not exceed £1,000, whilst it is expected that a saving of £250 per annum will be effected in the maintenance. With respect to the other property transferred to the Company by the Government, which is no longer required for the purposes of the line, the Directors recommend that it should be immediately disposed of on the most favourable terms. The 200 miles of new cable on board the steam ship *Sir James Duke* may shortly be expected to arrive, and the board have made preliminary arrangements for disposing of it at once. They also propose to realise, subject to the approval of the Lords Commissioners of Her Majesty's Treasury, as much as possible of the property at the various stations on the Red Sea, including the station-house at Aden, built by the Red Sea Company, at a cost of upwards of £5,000, together with as much of the submerged cable as can be recovered, either by contract or otherwise, without cost to the Company. The shareholders are aware that the Directors have thus far given their services to the affairs of the Company without remuneration, and they propose to do so, at all events, until the undertaking is in a position to pay a satisfactory dividend. The engineers of the company, Sir Charles Bright and Mr. Latimer Clark, have also stated their desire that their services to the Company, until further notice, should be rendered gratuitously."

The Chairman said that after unavoidably taxing the patience of the shareholders with six pages of report and correspondence with the Secretary of State for India in Council, it was unnecessary for him to trespass at any length on the time of the proprietors. By the report they were informed that the Secretary of State for India in Council had determined that the construction of the line between Bagdad and Kurrachee should be carried out by the Government of India. The Government was not prepared to entertain the application for a guarantee to enable the Company to renew a Red Sea line. The line between Alexandria and Jubal worked well, and a return of the traffic showed that should the present receipts continue, a balance of profit would be left equal to £5 10s. 8d. per cent., and the traffic was steadily increasing. Having referred to various minor points, the Chairman said the Board were prepared to carry out the views of the proprietors whatever they might be: and, in conclusion, he begged to move the adoption of the report.

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Mr. William Dent said that, concurring as he did in what had fallen from the Chairman as to the six pages of report and correspondence, he would not trespass on the time of the meeting, but would simply second the motion.

Mr. Henry Smith did not rise to oppose the adoption of the report, for in every word of it he cordially agreed. The Chairman recommended that they should continue the land line, and it appeared the receipts were increasing from week to week in a manner which amply justified the statement that it was paying; but the question was, how far their property was affected by the line from Bagdad to Kurrachee? It struck him that much of their traffic would be diverted into another channel. Towards the conclusion of the report it was stated, he thought very rightly, that with the 200 miles of new cable it was proposed to realise as much as possible of the various stations on the Red Sea. Now, he wished to know what was to be done with the proceeds? Was it to pay off a portion of the shares on which £1 had been paid? But, after all, he believed their property was in a prosperous condition. Before he sat down he wished to draw attention to a circumstance of vital importance, and that was the refusal of the Government to permit this Company to construct the line from Bagdad to Kurrachee. The Company had been subject to very unfair treatment. The Government had induced them to lay out their capital, and to ship 200 miles of cable; and they then raised obstacles in the way which materially affected the prospects of this line. Under these circumstances, was there anything like a satisfactory solution of the difficulty? He confessed that the letter he had read from the Government seemed, on the whole, satisfactory. It was said that it was not to the interest of the public to permit any private company to construct the line from Bagdad to Kurrachee, but there were obvious reasons why a telegraph would be worked better by a private company. He could not omit saying that the conduct of the Directors in giving their services gratuitously was beyond all praise.

Dr. Billing said the Government had given them a guarantee for a certain line, but they had been guilty of what in private life would be termed sharp practice, for it was like the case of a man selling a business to another, and then setting up in opposition in the next street. With regard to the Directors, he knew they were perfectly indifferent, not as to the fate of the line, but as to what determination the shareholders might come to. But they had, to a certain amount, funds from the cable and other property. Were they to be considered as funds in hand? It appeared there were funds or profits equal to £5 10s. 8d. per cent. Presuming this money was in hand, he put it to the Directors whether it would not be wise to declare a dividend, however small it might be, to give a better tone to the stock in the market. He was decidedly against shutting the Company up whilst they had a paying line.

Mr. Sebag bore testimony to the zeal of the Directors and to the manner in which they had strictly adhered to what emanated from the Board at the last meeting. Having complained of the unfair treatment which the Company had received from the Indian Government, he recommended that there should be an expression of feeling from the proprietors to the East Indian Government in council, stating how unfairly the Company had been treated, and demanding compensation, giving plenary powers to the Directors.

The Chairman said, that the proprietors having expressed their confidence in the Board, he trusted they would continue to deserve it. The various points referred to had been well considered by the Directors before the report was prepared. There was no intention whatever of extending the capital. With reference to the land line in Egypt it was necessary it should be placed in a state of thorough proficiency, and that the posts should be examined and renewed where necessary. The whole cost of a thorough inspection would not exceed £1000. The Directors thought it better to apply that amount rather than declare a dividend. With regard to the Government, the Treasury and the Indian Board did not always act in concert. If they could arrange to lay a portion of the cable on the Persian Gulf line, the cable being in good condition, the Government would use it. The Gulf line would no doubt take away the whole of the traffic of the existing line.

After a long conversation on various details, the question was put and the report was unanimously agreed to.

On the motion of Mr. Sebag, a vote of thanks to the Chairman and Directors was carried with acclamation.

The Chairman acknowledged the compliment and the meeting separated.

ATLANTIC TELEGRAPH COMPANY.

On Friday, the 12th inst., an extraordinary general meeting was held at the London Tavern, the Right Hon. P. Stuart Wortley in the chair, for the purpose of receiving a statement from the Directors, and considering a proposition for the issue of £600,000 new capital, in shares of £5 each, and bearing 8 per cent. interest, guaranteed, in case of success, by the British Government; any further profits to be appropriated, in the first instance, to paying a dividend of 4 per cent. on the old capital, and beyond that amount to an equal division between the old and new shareholders, and the formation of a reserve.

Mr. Saward, the company's secretary, having read the notice convening the meeting,

The Chairman proceeded to say that he had, in the first place, to congratulate the shareholders upon their increased attendance at the present, as compared with the recent meetings of the company; and in the next place upon the fact that, since he had had the honour of occupying the chair, he had never had the pleasure of meeting them in so happy a state of mind as on the present occasion. That did not arise from any new accession of Government support, or of any additional extraneous aid from other quarters, but was chiefly derived from the great revival of interest on the subject of telegraphic communication between the Old and New World, and the increased disposition on the part of the public to encourage the Board of Directors in their new efforts to complete so great and important a work; and here he had to congratulate them on the circumstance that all the privileges and exclusive rights of the Company were still in their possession, perfect and intact. From time to time there had been communications between the Government and the Directors for the surrender of some of those privileges and rights on certain conditions; and those who doubted the wisdom of such a course would be gratified to learn that the Company had still the exclusive right to land their cable upon the shores of Newfoundland, and still possessed all the privileges formerly conceded to it. There were two other grounds of increased hopefulness in the future success of the undertaking, arising from the additional knowledge and experience obtained in the science of electric telegraphy; and, so far from the public impression being well founded that the submarine lines which have been laid down have been failures, all of them, with one exception—and that was one which had been destroyed by the anchor of the Royal Charter, near Holyhead—were in perfect working order. Another circumstance worthy of notice was, that whereas it had been apprehended that there must be a large expense incurred in the repairs of a deep sea line, it was a fact gathered from experience, that whilst accidents had from time to time occurred to the lines laid in shallows, not a farthing had yet been necessary for the repair of any of those placed in deep waters. Their line, with the exception of the shore ends, would be in such deep waters, and be so perfectly placed, and have so equal and soft a bottom, that there was no reason to expect that any injury would arise to it from chafing or attrition. Another great ground of encouragement lay in the improvement of the means of laying cables. Messrs. Glass, Elliot, and Co. had laid as many as forty cables, and they were all at this moment in the most perfect working order. One of those—that from France to Algiers—had been laid in 1,800 fathoms of water, whereas the greatest depth of the Atlantic between Ireland and America was only from 1,600 to 1,700 fathoms. They had, too, acquired the most perfect command over the cable while laying it; for, in the instance of the cable he had mentioned, they had been able to raise it from the bottom, cut out a kink, splice the line, and relay it with the most perfect ease. The instruments, too, had been most wonderfully improved; and he would especially call their attention to a letter in a scientific journal, written by Mr. Varley, the eminent electrician, in which he clearly showed that the facilities of insulation had been increased tenfold, that the conducting power of copper had been greatly increased, and that there was a surer method of detecting leakages than had hitherto been the case. These facts gave them great encouragement, and assured them that at a moderate outlay a perfectly efficient cable might be laid across the Atlantic. There would, too, be but two stations, one in Ireland and the other in Newfoundland, to attend to, so that they might afford to keep attached to them men of the first ability and intelligence. These circumstances combined to give them great encouragement. He knew that in some quarters it had been doubted if they had ever sent a message by the old cable. They had sent more than four hundred, and three of them were of the most signal character. A collision took place between the *Europa* and the *Arabia*, off the coast of Newfoundland, and within twenty-four hours the relatives of all on board those vessels were informed, not only of the safety of their crews and passengers, but also of the preservation of their cargoes. The treaty with China, too, was, through the means of their cable, made known in New York twelve hours after it was known in London. The only other message to which he would pecially allude was one of great public importance. The War-office,

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during the time of the Indian mutiny, had sent out orders to regiments stationed in Canada to repair to the East. A short time after that order had been forwarded to the colony, good news arrived from India, which rendered the despatch of any further troops unnecessary. The War-office at once telegraphed to Canada a message which was received there in twelve hours, countermanding the departure of the troops referred to, and thus the country was saved an outlay of from £50,000 to £60,000. (Hear, hear.) These facts showed that, so far from the former cable being a disappointment, the circumstances under which it had spoken ought to be their greatest encouragement. But he might be asked why it was that it had failed? He was unwilling to go into details, but he could, if challenged, lay bare a state of things connected with it which would amply explain its failure. He would only now say that it had been laid with too great haste, that it had been ill-constructed, and in no fit state to go to the bottom; and that, on the whole, the company had not been well served by those to whom they had given their confidence. Such being the circumstances under which it had been laid, the miracle was that it had ever spoken at all; but notwithstanding all the disadvantages he had enumerated, they had demonstrated that it could speak with effect, and to the saving of mental suffering, the speedy communication of the most important commercial news, and the saving of a vast amount of expenditure to the country. He would now pass to the proofs of the revival of public confidence in the undertaking. He had said that scientific men were all agreed that it could be carried out with success. One of them, Mr. Fairbairn—perhaps the highest authority on electric science in the kingdom—had the fullest confidence in it, if the insulation were only made complete. He had, by his own experiments, proved that the improvement in the manufacture of gutta-percha had been so great that its porosity under the pressure of 20,000 lbs. did not exceed ·40. Although Mr. Fairbairn, through his age and other engagements, was unable to join the direction, he had yet assured them that it would give him the greatest satisfaction to make himself useful to the Company. They were also encouraged by Professor Wheatstone, and by Professor Thompson, the most distinguished electrician to be found the other side of the Tweed. There was another most important point to which he would direct their attention. At the time the last attempt was made, little was known of the bottom of the Atlantic. Lieut. Maury had certainly proved that between Ireland and Newfoundland, there was, in the bed of the Atlantic Ocean, a level spreading to the breadth of about 1,700 miles, and that that flat bottom was composed of a substance not likely to be injurious to a cable; but of the state of the bottom at the shore ends very little was known. It was a fact that at both ends the cable had been laid across rocks, where the attrition was so great as to cut through the insulation; and on the Newfoundland side it was found that the rocks in Trinity Bay, containing copper, had acted electrically upon the wire. Since then the Duke of Somerset had, on his representation, ordered a survey of the bottom at the shore ends for a distance of four hundred miles from either coast, and the result, made known two days since, was most satisfactory. It was now found that at about 300 miles from the Irish coast the sea increased in depth from 350 to 1,750 fathoms. The general opinion was, that there existed there a huge precipice, and that their cable was hanging suspended, as if it passed over the Alps from one peak to another; but in reality there was a shelving of such easy gradients that a locomotive might travel up them. There were many turnpike roads with a greater ascent, the dip in no instance exceeding 19 in 100. The face of that slope was covered with a soft clay, called "ouze," and the deposit was going on so rapidly, that a cable laid upon it would soon be covered over, and thus become sealed against all external agents; unless there was a volcanic action going on at the bottom, which was not likely to be the case in the latitude in which it would lie. The lightest cable was the one most likely to succeed, as there was no liability of its being chafed, for at the depth of sixty fathoms the sea was perfectly free from currents and agitations of every kind; and the bottom being composed of small shells, the cable would lie upon it in the most perfect tranquillity. On the coast of Newfoundland, too, they had found a place for landing the cable where the bottom was one of soft mud and clay, and which was forty miles nearer than Bull's Bay, so that in the length of the cable there would be a saving of £10,000. If they succeeded in laying their cable, it would be the only channel of communication between the 150,000 miles of telegraphs in Europe and Asia, and the 40,000 miles of telegraphs on the other side of the Atlantic, and that could not fail to be very profitable to them. There was no doubt that the length of wires in America would be extended to a still greater extent—to an extent almost illimitable. To show the rapidity with which messages were now communicated, he might mention that one was sent the other day from New York to San Francisco, a distance of 3,500 miles—the difference in solar time between the two cities being three hours and a quarter—and replied to in the short space of two hours. However, to revert to the prospects of the Company, he had to mention that the New York and Newfoundland Company were ready to give them a bonus of 40 per cent. cash discount upon the price received by them from the public upon every message the Atlantic cable brought to their lines, and he had an assurance from Mr. Cyrus Field that there was on the part of the American Government every desire to encourage it. The expense of laying a new cable of the description proposed would not exceed £400,000; but still the Directors thought it right to raise £600,000 additional capital, to which the Government guarantee of 8 per cent. would apply if the cable proved successful. The American Government was to subsidize them to the extent of £14,000, and the British Government was to pay them the like amount for the transmission of its messages. With their borrowing powers they had the right of increasing their capital to £2,000,000. The new shares would, in order to enable all classes to share in the enterprise, be £5 shares, and to their benefit the whole of the 8 per cent. guarantee would be appropriated. He, however, expected to find the Company earning far more than the guarantee—he would say 20 per cent. After the 8 per cent., up to 12 per cent., the additional 4 per cent. would be applied to the benefit of the old shareholders, who had made great sacrifices, and acted with the greatest liberality, and all above that 12 per cent. would be divided equally between the two classes of shareholders. He would impress upon the old shareholders that if they wished to recover their money the present was the time for them to come forward and subscribe to the new undertaking, which would make their old dead capital remunerative. He was happy to say that they had got Mr. Wm. Brown, of the eminent firm of Brown, Shipley, and Co., to rejoin the board. They had also secured the co-operation of Mr. Cropper, of the firm of Cropper and Benson, and that of Mr. George P. Bidder, and of the Hon. Mr. Grimston—these gentlemen being connected with the principal land telegraph companies. He would conclude by saying that the confidence of the public in submarine telegraphs had increased, was increasing, and ought to be further increased, and would move, 'That it is highly desirable to raise a sufficient amount of new capital, by subscription, at this present moment, in shares of £5 each—£1 payable on allotment—for the purpose of laying a new cable from Ireland to Newfoundland."

Mr. Lampson seconded the motion.

Mr. Kimblen inquired how the new cable was to be tested.

The Chairman replied that it would be subjected to whatever test the Scientific Committee of the Board, consisting of Mr. Fairbairn, Professor Wheatstone, Professor Thompson, Mr. James Whitworth, and other scientific gentlemen, might direct. Messrs. Glass, Elliott, and Co. not only undertook to invest £25,000 in the enterprise, but undertook the entire risk of laying the cable, so that, for their own sakes, they would have the deepest interest in having the cable fully tested.

Mr. Varley having explained the different kinds of tests, the motion was unanimously adopted.

The Chairman announced that some of the first city houses, Mr. Bates, of the firm of Baring Brothers, Jones Lloyd, and Co., and other gentlemen, had already subscribed upwards of £60,000. He then proposed—

"That for this purpose it is expedient that a prospectus be issued, stating the present position and prospects of the company, and inviting subscriptions to the amount of £600,000 on the following terms:—viz., 1. The shares of the new capital to be preference shares, bearing 8 per cent. interest, guaranteed by the British Government on completion and working. 2. Any further profits to be appropriated in the first instance to paying a dividend of 4 per cent. on the old capital. 3. Any profits beyond this amount of 8 per cent. and 4 per cent. to go towards an equal division between the old and new shareholders and the formation of a reserve fund."

Mr. Bushell seconded the motion, and recapitulated the arguments in favour of the renewal of the undertaking.

The Chairman, in reply to Mr. Bradlaugh, stated that the guarantee would only apply to the £600,000 new capital.

Several gentlemen having expressed their confidence in the undertaking, the motion was unanimously adopted.

Mr. Cavan then moved:—"That this meeting pledges itself collectively and individually to use their best exertions to spread information among the public, and obtain subscriptions for the completion of this great, hopeful, and beneficent enterprise, so important to the peace and commerce of the world."

Mr. Cyrus Field seconded the motion, assuring the meeting of his unabated confidence in the success of the scheme, and of the undiminished favour with which it was received in America.

The motion was then adopted unanimously, and the proceedings terminated in the usual manner.

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The Student.

THERMO-ELECTRIC CURRENTS IN CIRCUITS OF ONE METAL.

The preceding experiments show that a continuous current of electricity may be produced without any expenditure beyond that of the fuel which is necessary to maintain the electrolyte in a state of fusion. The globule of borax corresponds to the dilute sulphuric acid of an ordinary voltaic cell, the heated platinum to the positive element, and the colder metal to the negative element. Other metals may be substituted, sometimes with advantage, for platinum; and the arrangement may be varied by employing different metals for the positive and negative elements respectively. Again, a large class of substances which, when quite free from water, are very perfect non-conductors at ordinary temperatures, may be employed as electrolytes when fused. As a general rule, all compound bodies of which the insulating property is at all affected by heat become very good conductors when reduced to fusion. For the benefit of those of our readers who may be inclined to undertake further experiments in this interesting and comparatively uninvestigated branch of electrical science, we may mention the following bodies which were found by Faraday to be non-conducting when in a dry and solid state, and to become electrolytes when liquified by heat.

Oxides.—Potassa, protoxide of lead, teroxide of antimony (glass of antimony), protoxide of antimony, oxide of bismuth.

Chlorides.—The chlorides of potassium, sodium, barium, strontium, calcium, magnesium, manganese, zinc, lead, antimony, and silver; and the protochlorides of copper and tin.

Iodides.—The iodides of potassium, of zinc, and of lead; the protoiodide of tin, and the bi-iodide of mercury.

Fluorides.—The fluorides of potassium and of lead.

Cyanides.—The cyanide and the sulpho-cyanide of potassium.

Sulphides.—The sulphide of potassium. Among the oxy-salts, are the chlorate of potassa, the nitrates of potassa, soda, baryta, strontia, lead, copper, and silver: the sulphates of soda and of lead; the subsulphate of mercury; the phosphates of potassa, lead, and copper; the superphosphate of lime; the carbonates of potassa and soda; the borate of lead; the chromate and the bichromate of potassa and the chromate of lead; the acetate of potash; the silicate of potash; and the manganates of potassa and soda.

Any of these compounds may be substituted for the borax (borate of soda) used in the experiments of Dr. Andrews; but extended experiment can alone determine those which might be used with advantage.

The suggestion contained in the following description of a thermo-couple with fused electrolyte, which we have constructed, may be useful. Both the metallic elements are in the form of a shallow tray, of which one is somewhat smaller than the other. The larger of the two trays is placed over the source of heat, and the substance used as an electrolyte is then melted in it. A few fragments of glass or flint being also placed in this tray, the smaller one, filled with water, is brought into contact with the electrolyte, without touching the metal. The circuit is completed by means of wires attached to the elements. Through the evaporation of the water from the upper vessel, the difference of temperatures may be maintained for a lengthened period. Ultimately, the effect of the decomposition of the salt is shown by the polarization of the elements, and a consequent loss of power; but in most cases the original power is restored when the circuit is broken for a short period.

The results obtained in the experiments of Mr. Fleeming Jenkin, to which we have referred, were traced to the electrolytic conduction of films of oxide upon two unequally heated wires. The following description of one of these experiments, quoted from a paper read before the British Association in September 1861, is of peculiar interest in relation to the present subject-matter.

"When two pieces of similar copper wire are connected with a galvanometer, and the end of one wire is heated, a momentary current flows from the hot wire across the joint to the cold one whenever they are suddenly brought in contact. While repeating this experiment, due to Sebeck and Magnus, I found that if the two ends of two such copper wires (being equally oxidized and annealed) were looped together, and held tightly in contact, little or no current could be observed when one of the loops was heated in the flame; but, when the two loops were separated, I observed a momentary current in the same direction as that produced when the hot and cold wire were suddenly joined, *i.e.*, from hot to cold across the joint. This fact excited my attention, and led me to consider what the acts of making and breaking contact could possibly have in common. I reflected that, when two wires are approaching or receding, they equally pass through points at every possible distance (within limits) one from the other. Thus I thought that the relative distance between the two wires might be the peculiarity which, being common to the two acts, might produce similar effects in each case. I, therefore, tried the effect of a loose contact between the two wires; resting the one wire very lightly on the other instead of pressing or pulling the two together.

"A permanent current was at once produced so strong as to hold the deflecting magnet of the galvanometer against its limiting stops. I then introduced resistance coils into the circuit, for the purpose of reducing the deflection; but, to my surprise, it was not until I had added a resistance equal to that of two thousand miles of the Red Sea cable, or about one thousand miles of the common No. 16 copper, that I reduced the deflections within the range of my galvanometer.

"The current could be maintained through this resistance for twenty minutes at a time. Not perfectly constant indeed; but not wavering more than was inevitable from the varying pressure given by the hand to the two wires. The current was strongest when one end of the wire was white hot, the other being dark red.

"I varied the experiment in many ways, using different galvanometers and different copper wires, but always with one result. A tight contact gave a barely sensible current; a loose contact gave a current which could be maintained permanently equal to that which would be produced through a similar resistance by the eighth or tenth part of a Daniell's cell; a strength sufficient to signal through a cable to America, if ever one be laid."

Law Intelligence.

COURT OF COMMON PLEAS, December 13.

(*Sittings at Nisi Prius, after Term for London, before Chief Justice* Erle *and Special Juries.*)

PASSMORE AND DYER V. BRIGHT.

Mr. Bovill, Q.C., and Mr. Hannen, appeared for the plaintiff; Mr. Lush, Q.C., and Mr. Crompton Hutton for the defendants.

The plaintiffs in this action are telegraphic agents, of Gresham-street, Old Broad-street, and the defendant, Sir Charles Bright, is the well-known telegraphic engineer.

The action was brought to recover a sum of £250, alleged to be due by way of commission, under the following circumstances:—

Towards the close of the year 1859 the Spanish Government, in consequence of an insurrectionary band having disembarked from the Balearic Islands at Barcelona, determined to establish a telegraphic communication between the islands and the east coast of Spain. The plan was to start the cable at one end from Cape St. Antonio, to run it by way of the three islands—Iviza, Majorca, Minorca, and then to conduct it from Port Mahon on the latter island back to the main land at Barcelona; £61,670 was the sum agreed to be paid by the Spanish Government for the completion of the work, and a Mr. Perry was named as the contractor. He, however, sublet the contract to a Mr. Henley, a well-known manufacturer of telegraphic cables. Mr. Henley, made overtures through the plaintiffs to Sir Charles Bright, with a view of being directed in the enterprise by the scientific knowledge of that gentleman.

It was agreed that Sir Charles should have £500 for his professional assistance, and it was further proposed that £10,000 should be set apart from the £61,000 to be paid by the Spanish government as an insurance fund against accidents, and that Sir Charles and Mr. Henley should be joint insurers, liable for all loss, and in the event of the affair being completed without any loss at all, that they should divide the £10,000 between them. Sir Charles, however, insisted that the insurance fund should be £10,500, and Mr. Henley not acceding, the negociation was in danger of going off. Thereupon the plaintiffs, who were employed as agents in the transaction, fearing that the negociation would be abortive, and that they would lose their commission, said that they would themselves pay Sir Charles the £250, the half of the £500, rather than this should happen.

To this proposal Henley acceded, and when Sir C. Bright was informed of what the plaintiffs had done, he at once met them by a written declaration that, in case the cable was successfully laid, they should not be the losers, as he would recoup to them the £250 thus advanced. The arrangement between the parties, therefore, stood thus:—Henley was to be at the sole expense of providing and laying the cable; Sir C. Bright was to receive £500 for his professional superintendence; the defendants were to receive 3 per cent. on the contract-money, which would amount to over £1,200; and then a guarantee fund of £10,500 was to be created, to which virtually Henley should contribute £5,250, Sir C. Bright £5,000,

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and the plaintiffs £250, the funds to be equally divided between Henley and the defendant in case of the cable being successfully laid, and he undertaking to recoup the £250 subscribed by the plaintiffs (Passmore and Co.). But in the event of the guarantee fund being diminished in consequence of the cable not being successfully laid, Henley and the defendant were also to submit to equal deductions from their proportions of the guarantee fund remaining for distribution. Supposing, therefore, the enterprize to be completely successful from the first, Sir C. Bright stood to receive altogether a sum of £5,750, out of which he undertook to hand over to the plaintiffs £250.

The expedition started to lay the cable in August, and whilst laying between Barcelona and Port Mahon, rough weather was encountered, and this caused more cable to be paid out than would otherwise have been necessary, though they had enough to reach to within four miles of the coast, and were in shallow water. Some expenses were incurred in consequence, and Sir Charles agreed to receive £5,300 instead of £5,750. Under these circumstances the plaintiffs claimed commission at 3 per cent. upon £5,500, and they also claimed the £250, which it had been arranged that they should be repaid. On the other hand the defendant contended that commission was due only upon the £5,300, and that he was not bound to pay the £250, because the cable had not been successfully laid, inasmuch as it did not reach from shore to shore, and the testimony of the defendant was most distinct that if the guarantee fund was at all diminished, his responsibility towards the plaintiff outside the 3 per cent. commission ceased.

The jury, which consisted of only 10, retired, and after an absence of about an hour sent down word that there was no chance of their being able to agree. His Lordship, however, would not consent to discharge them so quickly, and so remitted them back to their deliberations; when, after another hour had elapsed, they were released from their labours by the parties agreeing to a *stet processus*, which in unlearned language means that the jury should be discharged, that no further proceedings should be taken, and that each should pay his own costs.

We have received the following accouut of the facts in connection with this case.—Ed. E.

"In the beginning of 1860 a Mr. Perry, in the American Embassy at Madrid, obtained the promise of the contract for connecting the Balearic Islands with Spain, by means of two cables, with land lines through the islands, and a line from Cape St. Antonio to Cargalienta on the main land. The cables were to be of two conductors, from Cape St. Antonio to Iviza, from Iviza to Majorca, and from Majorca to Minorca, and a cable of one conductor from Port Mahon to Barcelona. No money was to be paid until one half of the line was completed and at work, that is to say, that Port Mahon should be connected with Spain, either by Barcelona or Cape St. Antonio. When this was done, one-half of the contract money was to be paid, the remaining half, making £61,800, when the whole had been laid and working fifty consecutive days without interruption. Mr. Perry applied, through Mr. Rich, to Mr. Henley to take the contract, and as the arrangements at that time were not completed with the Spanish Government, Mr. Perry, thinking that if some well-known name in submarine telegraphy was associated with the project, he would stand a better chance of obtaining the contract, was induced, by the recommendation of Mr. Passmore, who was Mr. Henley's agent, to apply to Sir Charles Bright. Sir Charles agreed to give his services in laying the line, taking half the entire risk, and half the expense of shipping and laying. Sir Charles required the sum of £10,500 for the risk of laying, fifty days guarantee, and £6,500 for the expense of laying, Sir Charles sharing in the profit and loss of laying, and in the risk. Sir Charles advanced the sum of £2,500 as his share of the expense of laying; the expense of making the cable being borne by Mr. Henley. This arrangement was afterwards altered, Mr. Henley wishing to take the expense of laying also, and offering to Sir Charles the sum of £500 for his proposed services, and £10,000 to cover the risk of laying, with fifty days guarantee, which would give Sir Charles Bright £5,500 clear profit, if everything went off successfully. Sir Charles, however, required £10,500 instead of £10,000 to cover the risk of laying, and as neither party would give way, it appeared likely that the negociations would come to a standstill. Seeing this, Messrs. Passmore and Co., fearing to lose their commission of 3 per cent., amounting to £1,500, made an offer to Mr. Henley to pay the £250 of the sum in dispute, out of their commission, to allow the business to be proceeded with. Under these circumstances, the cables were made, and, in due course, sent out. The short cables were laid first, without mishap, and the long cable started in favourable weather: but on the second day the sea became very rough, and, owing to the great depth, 1,450 fathoms (nearly a mile and a half), and the pitching of the vessel, sufficient break power could not be kept on the cable, for fear of its parting under the strain, so that more slack was paid out than had been estimated for. Consequently, when the vessel—the *Stella*—reached Minorca, there was not quite sufficient cable to reach Port Mahon The cable was, therefore, buoyed in shallow water, about four miles from Cape Cabellara. on the north side of Minorca, and a telegram was sent through the cable by Mr. Henley, to the effect that it had been successfully laid, meaning that the risk was over, the completion being then only a matter of time. Application was made to the Spanish Commissioner on board to allow the cable to be landed and connected to Mahon by a land line; but nothing could be agreed on, and, as it seemed likely to be some days before it could be completed, Sir Charles left for England. Mr. Henley then joined on twelve miles of cable left from the short ones, and after the shore end was laid there remained a break of 4½ miles to reach Mahon. He therefore telegraphed to England for 5½ miles of new cable, and left his brother to splice it in. Owing to the continued rough weather, this was not done until the 12th of January, and it was March before the 50 days, for which the guarantee was given, had expired. About a month afterwards, the Government paid the sum at which the contract was taken. Mr. Henley, besides the expense of the 4½ miles, was put to an extra expense of £900 for carriage of cable, labour, &c.; and he claimed the half of the £450 from Sir Charles Bright, to be deducted from the £5,750. After some demur this was agreed to. and Sir Charles was paid £5,300. It appears that, unknown to Mr. Henley, Mr. Passmore had obtained from Sir Charles Bright, a promise in writing that he would repay him the £250, providing the cable was laid successfully.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Fine Para	2s. 1d. to 2s. 2d. per lb.
Negro	1s. 1d. to 1s. 4d. „
Java	1s. 5d. to 1s. 6d. „

Gutta Percha.

Fine	2s. 6d. per lb.
Genuine Mixed	1s. 9d. to 2s. 0d. „
Ordinary Reboiled	1s. 0d. „

December 17, 1862.

Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	56 to 60	——
20	Do. B 7 per cent. till 1862 .	—	——	——
Stock	Electric Telegraph . .	100	98 to 100	——
25	Do. New	—	——	——
5	London District Telegraph .	4¾	4 to 3 dis.	——
10	Mediterranean Extension Tel.	all	3 to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ½	——
1	Do. registered . . .	all	⅜ to ½	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅝ to ¾ dis.	——
5	United Kingdom Telegraph .	3	¼ dis. to ¼ pm.	——

POPULAR INVESTMENTS IN SUBMARINE TELEGRAPHY.

We gladly call the attention of our readers to the fact that they will shortly have a favourable opportunity of sharing in the credit of a great and beneficial undertaking, and of materially proving their interest and confidence in submarine telegraphy. The shares in the Atlantic telegraph are to be issued at £5, a deposit of £1 per share being required in the first instance. By this course, the aid of the small capitalist will be secured in carrying out a project which has engrossed the attention of the civilized world for a period of some years, and which, though from its stupendous character it is still looked upon by many as an impossibility, appears now on the eve of successful accomplishment. To many who read these pages, we need scarcely hold out the prospect of a minimum return of 8 per cent. as an inducement

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to connect their names with such an undertaking. Hereafter, when an Atlantic cable has become a matter of history, it may be to our honour, as well as profit, to have furnished the "sinews of peace" for the swift lightning messenger, and to have contributed, to however small an extent, to link together the Old World and the New.

SIR CHARLES BRIGHT ON THE CONSTRUCTION OF A TELEGRAPH CABLE FOR LAYING IN DEEP WATER.

The following letter was addressed to Sir Stafford Northcote at the same period as that of Mr. Robert Stephenson, lately published in our columns:—

72, *Old Broad Street, May* 21, 1859.

Sir,—I have now the honour to submit my opinion upon the points contained in the Memorandum accompanying your letter of the 17th instant, relating to the requirements of a telegraphic cable 1100 nautical miles in length, to be submerged to depths varying from 100 to 2500 fathoms.

Question No. 1. There are electrical advantages in the use of solid wire, but I consider the mechanical benefit gained by forming a conductor of several wires, laid together in a strand, to be of superior importance, and I therefore recommend that a strand of pure copper wire should be adopted for the conductor of your cable.

Questions Nos. 2, 3, and 4. The dimensions of the conductor, and the thickness of the insulating material by which it is to be covered, are mainly dependent upon the speed at which it is desired to work through the cable when laid. I presume, however, that it is not your intention to incur the very great outlay necessary for the attainment of a rate of working equal to the speed which may be reached with short submarine lines, or wires suspended from posts, but that a moderate speed, say of ten words per minute, would suffice for your purpose. For the accomplishment of such a rate of working, I should advise that about 3¼ cwt. of copper should be used for the conductor to each nautical mile, which would make a seven-wire strand $\frac{6}{32}$ of an inch in diameter. The copper should be very carefully tested for conductivity during the manufacture of the cable, as very great variation has been found to exist in the capacity of different samples of copper wire of the same size and weight, and apparently equal in all respects.

The conductor should be covered to half-an-inch in diameter with the best gutta percha, and the compound of gutta percha, wood-tar, and resin, now usually applied by the Gutta Percha Company in their layers immediately over, and between, the wires insulated for submarine cables, by which a more complete adhesion of the surfaces in contact is obtained. The quantity of gutta percha thus applied (which should be laid in six separate coatings, three of the composition, and three of pure gutta percha, alternately), would amount to a little more by weight than the conductor, and would ensure an ample degree of insulation, if properly tested during the construction of the cable. With this object, in addition to the usual tests at the Gutta Percha Works, the cable, when finished, should be coiled in water, flake by flake, and there be tested with the greatest care, until the completion of its delivery on board ship.

Such a conductor as the above, if submerged without injury, could be worked well, without requiring an excessive amount of battery power, at the rate of ten words per minute, through the length which you have in contemplation; it would cost about £100 per nautical mile, and could be made in ten weeks.

Special attention should be paid to the construction of the joints in the conductor, and a series of resistance-coils of fine wire should be made before the departure of the cable, exactly representing the resistance of various lengths of the cable, by which, in the event of any defect or fracture hereafter, the position of the fault may be readily determined.

Question No. 5. I do not know of any process that I could recommend by which the insulation of such a conductor as I have described could be improved to any extent; but the addition to the outside of the insulator of any non-absorbent material (although not so good an insulator as gutta percha), would tend to reduce the degree of retardation proportionately to the thickness and insulating properties of the material so used. Nothing of the kind has been practically applied hitherto, and there are several points connected with its introduction which require further consideration and experiments.

Question No. 6. The form of outer covering which I should prefer would be governed by the depths to which the cable is to be laid, and the nature of the bottom.

Near the shore, and until the soft clay bottom, which is generally found at the greater depths, is reached, a strong covering of solid iron wire, tapering by degrees in its advance towards the deep sea, would, in my opinion, be the best and most permanent mode of protecting the conductor. In the greater depths, a combination of iron and hemp might be adopted, by which the specific gravity of the cable would be reduced, at the same time that sufficient strength and protection for the conductor would be preserved.

If you have not already obtained so many soundings upon the route over which the cable will be laid as to indicate generally the depth and bottom, they should be procured before deciding upon the form and dimensions of the outer covering; and before the actual laying of the cables commenced, careful soundings should be taken, any sudden variation in depth being very carefully examined.

If you are in a position to give me the information in regard to various depths on the track, I shall be glad to lay before you my opinion as to the form of outer covering to be used, with specimens of the system which I may recommend.

The manufacture of the conductor and insulating material should not be delayed on account of the outer covering, if time is as important in the execution of this work as your letter leads me to suppose.—I have, &c., Charles T. Bright.

THE ATLANTIC TELEGRAPH.

Telegraphic communication appears at last likely to become a realized commercial fact, instead of remaining, as it has done since 1859, merely a proven scientific problem. A great change has taken place recently in the feeling of the public as to the prospects of success in a well-directed effort to accomplish this work, and a conviction has gradually arisen that the few failures which awhile ago, from their individual magnitude, startled everybody concerned in these investments, have taken place from perfectly controllable causes which improved business arrangements, and the present advanced state of science and experience upon the subject have rendered almost impossible of recurrence.

It is not generally known, however, that nine thousand miles of submarine telegraph—some of it submerged in as deep water as the Atlantic—are at this moment in daily successful operation, nor that out of fifty-one separate projects, which is the total number of the submarine cable enterprises that have ever been projected, forty-four are at this moment in perfect work, and all earning large revenues. One firm—Messrs. Glass, Elliott and Co.—have never lost a single cable out of the thirty-one made and laid by them.

The Atlantic Telegraph Company (whose meeting of yesterday is reported in our columns this day), are now determined to carry their undertaking through. Besides their constituency, which is a wealthy and respectable body, we understand that they are backed by pecuniary support from Messrs. Baring Brothers, Jones Lloyd, George Peabody and Co., Samuel Gurney, and other houses of similar rank; and large as the amount of £600,000 appears to raise for such a purpose, yet there is little doubt that commencing under auspices of this character, the whole will be speedily forthcoming.

The directors have wisely endeavoured to popularize the undertaking on the present occasion by dividing the new capital into £5 shares, upon which the first deposit required will be one pound per share only. These £5 shares are guaranteed at 8 per cent. by the British Government, on the completion and working of the cable. The British and United States Governments also undertake to pay the company an annual subsidy of £14,000 each; and the company, moreover, possess the exclusive right to land cables upon all the practicable parts of the Eastern shores of North America, besides agreements with American Telegraph companies for the return in favour of the Atlantic Company of large discounts upon the receipts for all the messages passing over their inland lines into the cable.

Among the few difficulties which it has been possible for hostility to urge against the probable success of the Atlantic cable when once the new capital is raised, is the *alleged* sub-oceanic precipice about 300 miles from the coast of Ireland. This difficulty is now entirely dispersed. The British Government, at the request of the Company, sent out Capt. Hoskyn, in H.M.S. *Porcupine* to survey all that part of the coast of Ireland down to 1,740 fathoms depth. This he has performed in a very elaborate manner, and he reports to the Admiralty as follows:—"There can be no reasonable doubt but that the descent from the Irish bank to the bed of the ocean is all that we can desire for the laying of the cable. So far from being a precipice, a locomotive engine might run up some of the inclines, and many turnpike roads have steeper ascents." Capt. Hoskyn further says:—"The face of this slope, and indeed, the bed of the ocean everywhere here, when below the depth of

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500 or 600 fathoms, is covered by the soft clayey substance called by sailor's 'ouze.'"

This deposit, in the opinion of Professor King, who has been employed by the Government to report on the subject, is going on so copiously and unceasingly that a cable once laid would in the course of a few years be covered up, and for ever sealed against the action of external agencies.

A similar satisfactory examination of the Newfoundland terminus has taken place on behalf of the company by command of the Government, who employed Captain Orlebar in this service. Captain Orlebar reports the existence of a straight and deep channel up Trinity Bay to New Perlican, in every respect adapted for the repose of the cable, and for bringing it in safely and securely to land. The new route, moreover, indicated by Captain Orlebar will effect a saving of more than forty miles of cable—a somewhat important item in the Company's capital.

These facts, and the undoubtedly vast improvement that has been effected in every detail connected with the making and laying of cables since the submersion of the original Atlantic cable, and greatly due to the experience gained by its means, lead to a very confident expectation of complete success on the present occasion. This anticipation appears to be felt to the fullest extent by those who would be the greatest sufferers in case of failure, and where experience in these matters is the most extended. It appears that Messrs. Glass and Elliott express their perfect confidence that a good and durable submarine cable can be laid direct from Ireland to Newfoundland, and as a practical proof of their confidence, are prepared to manufacture and lay the cable upon terms which will entail upon themselves a heavy loss in the event of failure, while their profits will be contingent upon success. What they propose is, that the company shall pay them each week the amount of their actual disbursements for labour and material for the manufacture and laying of the cable, the weekly pay lists and vouchers to be submitted to and examined by the company, the contractors subscribing, in cash, a sum of £25,000 towards the capital of the company. A subscription to this large amount, by Messrs. Glass, Elliott, and Co., added to the condition that they are only to be paid their actual monies out of pocket in making and laying the cable, are the terms on which they are willing to carry the work to a successful issue. When the cable is laid and at work, they are however, to receive 20 per cent. on the outlay for their time, services, use of manufactory and machinery, and profit. This 20 per cent., however, is to be paid only in the shares of the company, and these are to be delivered by twelve monthly instalments, so that the full amount of 20 per cent. paid in the shares of the company will not be received by the contractors until the line has been actually in work for thirteen months. All the risk and responsibility of the manufacture of the cable will devolve upon the contractors, and the company will have nothing to do with the rivalries or the selection of engineers.

We annex the company's estimate of probable profits derivable from the investment in case of success. The result anticipated appears very large, though based upon what looks like a moderate assumption, namely, that an average of ten words per minute may be realized during 175 whole days, or rather less than half of each year. Mr. Varley and others give sixteen words per minute as the practicable rate of speed that will ensue from the new cable, and it must of course be borne in mind that the difference in time between Britain and New York and other American cities will certainly require this telegraph to be kept open night and day, as well as on Sundays.

Looking at the great importance and national interest surrounding this splendid and exceptional work, we cannot but heartily wish it success; and we must express a hope that the increased guarantees for care and watchfulness that now exist in its favour, and the popular character of the present issue of capital in shares of small denomination, will rapidly secure the means for carrying it into execution.

The following estimate of profits has been circulated:—

THE ATLANTIC TELEGRAPH COMPANY.

Annual commercial results of working a telegraph cable at a charge of two shillings and sixpence per word, and at an average speed of ten words per minute, during sixteen hours per day, throughout a year of 300 working days; the new capital being as now decided upon (£600,000), and the total capital, old and new, being as below stated:—

	Per year.
Ten words per minute (being a rate of speed lower by 30 per cent. than has been shown by Varley and others to be practicable), for sixteen hours per day at 2s. 6d. per word, the tariff authorized by Government, are equal to ... ... £1,200 per day.	
£1,200 per day for 300 days are equal to	£360,000
And Government subsidies	28,000
Add discounts agreed to be returned to the Atlantic Company by other telegraph companies, estimated to produce at least	50,000
Gross income	£438,000
Less working expenses in Ireland, Newfoundland, and London	25,000
Net profit per year	£413,000

NOTE.—The above calculation is based on the assumption that 240 messages per day may be sent from each side of the Atlantic. The undersigned has ascertained from actual returns kindly furnished to him by the two companies who possess the continental cables, that the average communication between Great Britain and the Continent alone exceeds, at the present moment, 1,500 messages per day, and is ever increasing.

CAPITAL.

	Per year.
The new capital, £600,000, bearing the first Preference dividend of 8 per cent. per annum, requires	£48,000
The old capital, £462,860, bearing the next Preference of 4 per cent., requires per year	18,514
Upon the total capital, old and new, £1,062,853, pay a further dividend of 10 per cent.	106,286
Out of profits there are thus:—	
Available for dividends	£172,800
Balance for reserve fund yearly	240,000
Net profit, as above	£413,200

22, Old Broad Street, London, Nov. 26, 1862. GEORGE SAWARD.

THE ATLANTIC TELEGRAPH.

THE following are copies of the report by Captain Orlebar, R.N., and the remarks of Mr. Leeming, the naturalist, thereon, received at the Admiralty, in respect to the recent soundings and examinations made by the Government for the Atlantic Telegraph Company at Trinity Bay, Newfoundland:—

SOUNDING OF TRINITY AND CONCEPTION BAYS, NEWFOUNDLAND.

Charlotte Town, Prince Edward Island, Nov. 24, 1862.

Sir,—Herewith you will receive the charts containing the soundings taken in Trinity and Conception Bays, and also eastward of St. John to the meridian of 50 deg. west. A dotted red line indicates the route I consider best adapted for the Atlantic Telegraph Cable, and for which I beg to submit the following reasons:—1. You will observe that it is only the most northern line of offshore soundings that gives muddy bottom, and that this leads right into the mouth of Trinity Bay. The soundings further south are more irregular, less deep, and give stones, rock, and sand. At the entrance of Conception Bay, the soundings have the same character, giving 50 fathoms less depth than Trinity Bay. 2. Also in Trinity Bay a channel with muddy bottom five miles wide and more than 130 fathoms deep can be carried from the offing more than 45 miles up the bay to New Perlican, where it approaches within a mile of the south shore. 3. The nature of the bottom was everywhere noted, and specimens of it have been prepared for the microscope by Mr. T. J. Leeming. The examination of these specimens, and of the rocks on the shore of Trinity and Conception Bays, which are of the silurian system, leads me to suppose that there is nothing on the shores, or at the bottom, likely to impair the working of the telegraph cable. On this subject I enclose a memorandum by Mr. T. J. Leeming, naturalist. 4. Trinity Bay is 20 miles wide at the entrance, and is well lighted by Cape Bonavista and Catalina Green Island Lights on the north side, and Baccalieu Island Light on the south. Icebergs generally ground on the shoal banks off Catalina and Cape Bonavista, and even those that enter the bays are most frequently driven over to the north side. 5. In Fitters Cove, New Perlican, which is too exposed for vessels to anchor, the bottom is sand, with scattered rounded stones, and at its head there is a beach of fine sand, on which the telegraph cable, if protected by a sheath of iron near the land-wash, might be safely landed. It would have to traverse for half a mile a rocky slope, having a depth of 30 fathoms, decreasing to 11 fathoms, but it appears tolerably even, and is too far within the bay to be visited by icebergs, or disturbed by the ocean swell. 6. On the northern side of this bay the soundings are more irregular, and the bottom rocky, whilst there is more ocean swell and more danger from icebergs. 7. For these reasons I think the western terminus of the ocean telegraph cable should be at New Perlican, and on that account I have prepared and transmitted herewith a plan of New Perlican on the scale of four inches to the sea mile.—I have the honour to remain, your most obedient servant,

JOHN ORLEBAR,
Captain in charge of Newfoundland Survey.

GENERAL OBSERVATIONS DURING THE SOUNDING OF TRINITY AND CONCEPTION BAYS, NEWFOUNDLAND, BY MR. T. J. LEEMING, NATURALIST &c.

Orders having been received on the 20th June to sound Trinity and Conception Bays, the steamer *M. Stevenson* proceeded at once to the scene of operations, and commenced sounding on the 3rd of July, running the first line from Baccalieu Island to Catalina Harbour. The coast from St. John to Cape St. Francis is very bold and rocky, especially near St. John, where the rocks are of great elevation and steeply scarped, so that, with the exception of a few sheltered bays and

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coves, landing is impracticable, the rocks for the most part of the Grauwacke system appearing of a coarse conglomerate, varying in texture from that of a sandstone to a concrete gravel. At Flat Rock Point at Torbay the different textures appear in alternating beds with an inclination of about 10° toward the north. At Cape St. Francis the rocks are slaty, with quartz and a small quantity of copper pyrites. The shores of Trinity Bay, as far as the survey extends, are also very abrupt. The Sugar Loaf on the south side consists of conglomerate, with quartz veins rising sheer from the water's edge to the height of 415 feet. Bonaventure Head, on the opposite side of the bay, in like manner rises to 467 feet. Some of the other elevations taken barometically) as follows:—Breakheart Point, 326 feet; Hants Harbour Hill, 123 feet; Mount Misery at New Perlican, 334 feet; Horse Chops, 263 feet. Towards Catalina and Cape Bonavista the shore is much lower, Cape Bonavista at the lighthouse being about 150 feet. The geological character of the rocks, as far as opportunity for examination offered, was as follows:—At Bonavista, alternating layers of sandstone and concrete gravel at an inclination of 40 deg. to N.N.W. At Catalina Harbour the rocks are slate, with a slight inclination varying from three to fifteen degrees towards the sea: on the north-east side of the harbour is abundance of cubical iron pyrites, called locally "Catalina spar." The other side of the bay is mostly of conglomerate, and towards New Perlican slate appears. The soundings, as indicated by the chart, give mud for the middle of the bay, while the south side is more rocky and gravelly. The mud appears to be of uniform character throughout: when dry, scarcely distinguishable, but when first taken up, that toward Trinity Harbour, and thence about half way across, is rather of a higher colour, while generally it is black or dark green. When washed in nitric acid and submitted to the microscope, the same appearance is everywhere presented, a considerable variety of siliceous organisms, among which will be found coscinodiscus cocconema, gallionella, cocconeis, navicular spicule, &c.; several washed portions have been in glass which together will be found to contain all the species that have as yet been noticed in these soundings. The mud of Conception Bay is identical in character, but not nearly so plentiful. Near Salmon Cove a cast of the lead brought up several scales having the appearance as to metallic lustre and colour of gold; but owing to the strong wind blowing at the time, the particles were scattered; one small scale was secured under glass, and is sent along with the sounding. The shores of Conception Bay are not nearly so wild as those of Trinity. With the exception of the extreme north of the bay about Split Point, which is of considerable elevation, the face of the rock and the natural fissures being inclined about 15deg. from the perpendicular, the vegetation extends nearly to the water: the greatest elevation being about Portugal Cove and towards the head of the bay. The lookout at Portugal Cove rises to the height of 530 feet; among the other elevations taken were Island Cove Head, 106 feet; Western Bay Head, 185 feet; Blowmedown, 182 feet; Spectacle Hill, at Cupid Cove, 308 feet; Brigus Lookout, 357 feet. At Spectacle Hill the rocks are clay slate, variegated with ferruginous layers, having a dip of about 36 deg. towards N. W.; the direction of the natural cleavage running N. E. At Blowmedown the slate is very fissile, and a vein of coarsely grained quartz about 18 inches thick traverses the station in a N. E. and S. W. direction. Bell Island is an elevated deposit, alternating strata of flag and slaty rock, of a nearly uniform elevation, save where worn into valleys of denudation; cliffs worn nearly, and in some places beyond the perpendicular by the action of the sea; beaches of slaty and conglomerate shingle at Lance Cove and Grand Beach. It has the character of being the most fertile land in Newfoundland—Kelly Island is nearly identical in character. The summer was unusually late this year: on the morning of the 17th June was a perfect snowstorm from the N. E., lasting fron 6 a.m. till noon. The ice was last seen in Conception Bay on the 21st ofAugust. A large berg was afterwards seen off St. John, October 2, its position at 10.30 a.m. was about 47.17 North and 52.15 West. There had been a fall of snow the day before.

SPECIFIC AND LATENT HEAT.

Different solids and liquids undergo different degrees of expansion. from the same quantity of heat, and we further observe that equal bulks of different substances require the addition of different quantities of heat, to produce the same change of temperature.

The heat entering in this manner into the composition of various substances, is called their specific heat, and may be thus conveniently illustrated.

Take a pint of water at 100° and mix it with a pint at 50°, the thermometer will indicate the temperature of the mixture to be 75°, which is as might be expected, being the precise arithmetical mean: now mix a pint of mercury at 100° with a pint of water at 40°, and it will be found that the resulting temperature is not the mean 70°, but 10° lower, viz.—60°, so that the quicksilver will lose 40°, whereas the water will only gain 20°: notwithstanding which, it is clear, that the water has gained the whole heat that the quicksilver has lost. Hence water has a greater capacity for heat than quicksilver, or it acquires a larger quantity of heat to raise it to a given temperature,

Again:—Take two similar glass bulbs, one containing water, and the other mercury, and immerse them at the same time in hot water, it will be found that the mercury bulb is heated up to the temperature of the water, in half the time that the water bulb requires; and if the two bulbs after having both attained the temperature of the water, be removed and exposed to the air, the mercury bulb will cool twice as rapidly as the other. All these experiments concur in proving that water has twice the capacity for heat that mercury possesses.

What is termed the specific heat of water, is not, however, to mercury as two to one. Since it is more convenient to express the capacities of different bodies with reference to weight than to measure, a pound of quicksilver at 40° agitated with a pound of water at 156°, produces a temperature of 152°3. The water thus losing only 3°7 of temperature, and the mercury gaining 112°3. Now 3°7 : 112°3 :: 0·033 : 1; consequently if water be taken as the standard of comparison as unity, the specific heat of quicksilver must be called 0·033, or, if which is more convenient, the specific heat of water be taken as 1000, then that of mercury will be 33.

Here we again have occasion to pause and admire the wisdom and benevolence of the Great First Cause, and to congratulate ourselves on the opportunities which science is perpetually affording us, of gaining distant gleams of the beauty and economy of the scheme of creation, opportunities which should be hailed with delight, and which ought to produce the effects for which it cannot be doubted we are permitted to learn them.

Water has of all bodies, whether solid or liquid, the greatest capacity for heat, and water covers four-fifths of the surface of our globe. What an immense magazine of heat is here! and how great and beneficial its influence in equalizing atmospheric temperature!

The most successful method of determining the specific heat of bodies, is to allow them to cool a given number of degrees, under circumstances precisely similar, enclosing them for instance in a highly polished vessel containing a thermometer; and standing under the exhausted receiver of an air pump. Dulong and Petit thus obtained the capacity for heat of the following substances.

Water	1000	Iron	110	Mercury	33
Sulphur	188	Copper	95	Platinum	31
Glass	117	Zinc	93	Lead	29
		Silver	56		

It must, however, be observed that it was ascertained by the same experimentalists in a very careful manner, that the specific heat of bodies increases as their temperature rises: so that it requires more heat to raise them a certain number of degrees when at a high, than when at a low temperature.

It may be shown also by familiar examples, that the capacity of bodies for heat, is very materially affected by their density. Suddenly compress a metal and it will become hot, because its capacity for heat is diminished; blacksmiths frequently light their fires in the morning by dexterously dealing a few heavy blows with a hammer on a piece of soft iron, the temperature of which becomes thereby sufficiently elevated to ignite a brimstone match. Indian rubber, again, becomes warm when stretched out, as may be proved by drawing it across the lip.

In fluids a very striking case is presented by mixing together sulphuric acid and water. It is found that sufficient heat is produced to boil water immersed in it in a test tube, and at the same time it may be noticed that the volume of the mixture is not the sum of the two fluids when separate, but less, showing a condensation to have taken place, which accounts for the diminution of capacity for heat. Alcohol and water present the same phenomena though in a much less degree.

High-pressure steam presents another remarkable instance of alteration in specific heat from change in density; a stream of it issuing from a small aperture into the atmosphere, instead of scalding feels scarcely warm to the hand held in it. Professor Brande gives also the following case in point. "A part of the machinery for working the mines at Schemnitz in Hungary, is a perpendicular column of water two hundred and sixty feet high, which presses upon a quantity of air enclosed in a tight resevoir. This air is consequently condensed to an enormous degree by this height of water, which is equal to between eight and nine atmospheres; and when a pipe communicating with this resevoir of condensed air is suddenly opened, it rushes out with

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extreme velocity, instantly expands, and in so doing it absorbs so much heat as to precipitate the moisture it contains in a *shower of very white compact snow*, which may readily be gathered on a hat held in the blast. The force of this is so great that the workman who holds the hat is obliged to place his back against the wall, to retain it in its position."—*Brande's Chemistry.*

The philosopher who first investigated the phenomena of latent heat, and who by the inquiry contributed so much to Experimental Philosophy, was Dr. Black, about the year 1757. Before this period, it was supposed that the state of fluidity was occasioned by the addition of a very small quantity of heat to a solid, when once raised to its melting point, and this was, *prima facie*, a reasonable supposition, it was also, and with equal appearance of probability, imagined that during the conversion, no greater addition of heat was received than the thermometer indicated.

It very frequently happens that facts which we have every day an opportunity of observing are disregarded however curious they may be, whilst those that occur rarely are much more likely to arrest our attention! In consequence of this craving for novelty, many highly interesting particulars escape us, till some master-mind, some philosophic spirit interposes, and opens from old materials, a new and extensive field of inquiry.

Thousands must have observed before the time of Black, that however cold ice may be, it soon becomes heated to its melting point when brought into a warm room, but that, nevertheless, it is a long time before it is entirely re-converted into water, and that a heavy snow always remains on the ground for a very long time after the breaking up of a frost, its reconversion into water being exceedingly gradual. Now, if the state of fluidity be occasioned by a small addition of heat to a solid raised to its melting point, the ice and snow ought to vanish presently, the heat continuing to be accumulated from the air around. This occurred to Dr. Black, who immediately set about inquiring what becomes of the heat that must keep continually entering the ice, without producing its liquefaction.

If a piece of ice be suspended in a warm room, the effect of the warm air, is rendered evident by the stream of cold air that constantly descends from it, and which may be felt on the hand. If the drops of water as they fall from it, be received on the bulb of a thermometer, the instrument will indicate the same temperature as the ice itself: viz.—32°.

Dr. Black made the following experiment:—He filled two similar globular glass vessels with water, one was afterwards frozen, and the other cooled as nearly as possible to the same point; they were then carried into a room the temperature of which was 47°, there being no other difference between them than that one contained water and the other ice. In half an hour the vessel containing the water had acquired the temperature of 40°; but in the other it required ten hours and a half to melt the ice, and to raise the water to 40°.

Now the access of heat being in both cases the same, and at the rate of 7° per half hour, it follows that in twenty-one half half hours (the time required to thaw the ice, and elevate the temperature of the water to 40°,) it would have received 7 + 21 = 147°. The difference therefore between the increase of temperature in the ice, and water vessels, with equal accessions of heat is one hundred and forty degrees, will express the quantity of sensible heat rendered latent by the operation of liquefaction.

The same number is brought out by other methods of experimenting. Equal weights of water at 32° and 212°, will, as we have shown before, produce on mixture the mean temperature of 122°; but equal weights of *ice* at 32°, and water at 212°, only produce, after the ice has melted, a temperature of 32°, the water loses 150°, while the ice acquires only 20°; now 160°—20°, gives 140°, as before, for the quantity of heat expended in changing the ice to water; for the quantity of latent heat on which the fluid state depends. But this heat is not annihilated, although to the feeling and to the thermometer it is insensible; this is proved by the following experiment, also made by Dr. Black. When the thermometer stood at 22° in the open air, he exposed two similar vessels, one full of water, and the other of brine, both at 52°; both lost heat until they were cooled to 32°, after which the brine (which does not freeze till cooled down to 4°) continued to lose heat without interruption, and gradually reached 22°, the temperature of the air; but the pure water remained stationary at 32°, when ice began very slowly to form; now, can anything be plainer from this experiment, than that the reason of the water refusing all of a sudden to give out heat, is, that its temperature was maintained by the heat which it absorbed during its liquefaction, and which it slowly evolved during its conversion into ice?

Dr. Thomson has concluded from many experiments, that the quantity of ice which forms suddenly on the agitation of water, cooled down below the freezing point, bears always a constant ratio to the coldness of the liquid before agitation, and that from analogy it was probable, that for every five degrees of diminution of temperature below the freezing point, without congelation, one twenty-eighth of the liquid freezes suddenly on agitation. Therefore, if water could be cooled down twenty-eight times five degrees below 32° without congelation, the whole would congeal instantaneously on agitation, and the temperature of the ice would be 32°. Now, observes Dr. Thomson, it deserves attention, that 5 × 28 = 140, gives us precisely the quantity of heat which, according to Black's experiments, enters into the ice, in order to convert it into water. Hence it follows, that in all cases, when water is cooled down below 32°, it loses a portion of the heat which is necessary to constitute liquidity.—*Noad's Lectures on Chemistry.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

In looking carefully through the list of cables manufactured and laid by Messrs. Glass, Elliot, and Co., I find they have on two occasions only been engaged in laying deep sea lines, viz., the Toulon and Corsican cable, a length of 195 miles only, and the Algerian cable, a length of 520 miles; this line, unfortunately, has just given way, so that really they cannot boast of much experience in laying deep sea cables. The long line from Malta to Alexandria, 1,535 miles, submerged in shallow water, is entirely in their own hands, so that they can acknowledge or disclaim as they please the statements published by Mr. Saward, the Secretary to the Atlantic Telegraph Company, with regard to the speed at which messages can be transmitted through this line. To the uninitiated some explanation might be useful, but those who *understand* what is required to work through long lines of gutta percha wire need no information *from them.*

In further noticing their own advertisement, I very much question if there are not other firms in London who would gladly undertake the contract for manufacturing and laying a new Atlantic cable at half the rate of profit they propose, and at much less cost to the Company.

And I would add, with regard to iron-covered cables being used for deep seas, there is nothing to warrant this, excepting from those who have a large number of machines, which would become valueless if light hempen cables, as suggested by the late Mr. R. Stephenson, were at once generally adopted.

In conclusion, sir, I noticed that Mr. Saward, the Secretary to the old Atlantic Telegraph Company, announced on Friday, the 12th ultimo, at their meeting, that two firms were willing to subscribe seventy-five thousand pounds towards this undertaking. No names were mentioned, so that the public are at liberty to form their own opinions as to whether it is not possible that this large sum is not really promised by Messrs. Glass, Elliott, and Co., of Greenwich, and the wealthy Gutta Percha Company, of the Wharf Road, City Road, London.—I am, yours obediently, A. B.

To the Editor of The Electrician.

Sir,—I have often been much puzzled to ascertain what really constitutes a thorough practical telegraph engineer, and am still labouring under the same difficulty; and from some of the great errors committed in almost all large undertakings, I am induced to imagine that there is not sufficient attention given to the subject, or that those who ought to know really are not in the position to place the appointment in the hands of men who are known to have studied the branches of the science.

Great schemers are generally successful, and the man who possesses a number of perhaps the most useless patents, and also pretends to know a great deal of everything, but nothing in particular as regards the practical knowledge required, appears to have been generally employed, and the success of their undertakings has often led them to say, "Thank God that's done, but I really did'nt expect it."

But the time is now arrived for the practical man's knowledge and experience to be tested; and now we know that india rubber is very far superior to gutta percha of the present day, or any of its unknown compounds, the difficulties in the way of progress are fast fading away, and with it many of the fallacious opinions formed by men who are always too ready to stop the development of this or any other important science.

The desirability of extending the telegraph to every country in the world is acknowledged by all; and the delay, in my opinion, is caused entirely by those who profess for this extension, but lack the practical

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knowledge of carrying it out, and the money provided is too often expended to enrich those who trade largely upon the credulity of others in trusting to their respectability and position.

It has often been urged in your journal that many of the fatal errors in submarine cables have been caused through the ridiculous principle adopted in construction—viz., the using of a gutta percha core, which is hard and brittle, and entirely free from the slightest elasticity, and afterwards encasing it with a spiral, and, when strained, elongating coating of iron or steel wire, warranted on principle to kink to any extent, very much more than gutta percha can withstand. But the same external covering carefully applied would not affect an india rubber core, as the whole would be elastic under strain, and would of necessity all yield together; but I would not advocate the use of spiral coverings in any form, as the wearing or rusting away of one wire exposes the core to immediate danger, and certain ultimate destruction.

It would seem that very little regard is paid to the "Government Report" for the proper construction of a good submarine cable, and it is much to be feared that another great failure will soon be added to the many, in spite of the success that Messrs. Glass and Elliott would have us believe in.

It would be highly interesting to have a debtor and creditor account of all cables laid, to show the number of miles now in actual working order. This may be difficult, but would be well worth the trouble.—I am, sir, yours respectfully, CITIZEN.

THE ATLANTIC TELEGRAPH.

To the Editor of THE ELECTRICIAN.

SIR,—The ignorance of the representatives of the public press with regard to telegraphy is much to be deplored. The reports which have appeared in the daily papers of the meetings of the Atlantic and the Telegraph to India Companies are evidently the "cram" of interested parties. Had the representatives of the press, present at those meetings, been as well informed in the science of telegraphy as they are in other kindred sciences, those reports would have been very different.

It is to me a matter of surprise that our intelligent London bankers and merchants should allow themselves to be led, or rather misled, by parties who have only in view the manufacture and sale of their patent instruments. Mr. George Parker Bidder recently declared that the *curse* of telegraphy was the patentee. Yet we find that the same gentleman, as one of the Directors of the Atlantic Telegraph Company encourages the perpetuation of the *curse* which he so eloquently and commendably denounced.—I am, sir, yours respectfully, B. B. D.

Telegraphic News.

AT the meeting of the Telegraph to India Company (Limited) held on Friday last, the report was unanimously adopted. The Indian Government have determined to construct the line from Bagdad to Kurrachee. The company's line between Jubal and Alexandria continues to work most satisfactorily, the traffic being on an average £170 per week. The Indian Government refuse the application for a guarantee to enable the company to establish a new Red Sea line. The Jubal and Alexandria will nevertheless pay £5 10s. 8d. per cent. on the average. The directors therefore recommend the company to continue to work the land line in Egypt and the cable between Suez and Jubal, retaining the firmans, instruments, and other property in Egypt; as in the event of the Bagdad line proving inadequate to the commercial requirement, or from any other cause which shall indicate the need of an alternative means of communication, the company would no doubt receive the cordial support of her Majesty's Government and of the public in continuing the line. The 200 miles of cable which is expected shortly to arrive will be disposed of at once.

AN extraordinary general meeting of the shareholders of the Atlantic Telegraph Company was held on the same day, at the London Tavern. The Right Hon. James Stuart Wortley, who was in the chair, explained at great length the position and prospects of the company, assuring the shareholders that he considered the latter far more favourable than they had hitherto been. Three resolutions were agreed to—the first to the effect that it was highly desirable to raise a sufficient sum, by subscription, in £5 shares, £1 payable on allotment, for the purpose of laying the new cable from Newfoundland to Ireland. The second resolution stated that preferential shares should be issued to the extent of £600,000, bearing 8 per cent. interest (guaranteed in case of success by the British Government), further profits to be appropriated in the first instance to paying a dividend of 4 per cent. on the old capital, and beyond that amount the profits to be divided between the old and new shareholders and the formation of a reserve fund. The third resolution pledged the meeting to spread information with reference to the undertaking, and to endeavour to obtain subscriptions for its promotion. The chairman expressed his conviction that the line would earn 20 per cent., so that the new shareholders would get 8 per cent., and half of 8 per cent., making 12, and the old shareholders would get 4 per cent., and half of 8 per cent., making 8. It was announced that £70,545 had been subscribed, and that amongst the subscribers appeared the names of Mr. Bates of Baring Brothers, Jones Lloyd and Lewis Lloyd, of Jones Lloyd and Co., and others.

A NOTIFICATION has been advertised that a new undertaking for laying a telegraphic line to America, has been formed under Continental support, and will shortly be introduced.

A PECULIARLY prepared cord or twine, is often employed by the Laplanders, in place of the sinews of the reindeer, for sewing together the thin planks of fir, of which their boats are formed. The cord is dressed with a kind of red glue, prepared from the skin or scales of fish. Thus prepared, it is impervious to air and water, and is rendered very durable. (*Vide* "Regnard's Journey to Lapland.") This fish glue might very possibly be found adapted for the preparation of hemp, employed for covering submarine cables.

Miscellanea.

THE old wonders of the world exposed prodigies of labour, rather than of art, and therefore Egypt and China were unable to claim half of them. The marvellous statue was a miracle, not of sculpture, but of size, and the marvellous fabric was not a perfect temple, but a monstrous wall. We ought to have outlived such estimates at the present day, and yet we are by no means sure that we have done so. Magnitude and numbers still produce extraordinary impressions. Enormous totals affect the imagination more probably than simple achievements of science, probably because they use multiples of some standard already familiar to the mind. The electric telegraph is a real wonder. A description of some such machinery was thought too extravagant a piece of fiction, even for an oriental tale, and yet, we doubt if the easy and instantaneous connexion of two distant points, is actually thought half so marvellous as a great ship or a monster gun.—*Times*.

THE conduction of heat in bars, and the conducting power of wrought iron, is the subject of an elaborate paper, by Principal S. D. Forbes, of St. Andrews, in the new part of the *Transactions of the Royal Society of Edinburgh*. In the early part, he refers to his conclusion, "that the arrangement of the conductors of heat does not differ from that of conductors of electricity, more than either arrangement does alone, under the hands of different observers." At the close, he says, in reference to the experiments described, "the diminishing conducting power of iron with increased temperature, harmonises with similar facts in electricity, thus adding a fresh analogy to the conclusion given above." According to the recent experiments of Arndtsen, "the resistance to the transmission of electricity through iron, is increased nearly one half by a rise of temperature of 100 degrees centigrade."—*Illustrated London News*.

ON CHLOROFORMIC SOLUTION OF GUTTA PERCHA BY WILLIAM HODGSON, JUNR.—Take of gutta percha, in small slices, an ounce and a-half; chloroform, twelve fluid ounces; carbonate of lead, in fine powder, two ounces. To eight fluid ounces of the chloroform contained in a bottle, add the gutta percha, and shake occasionally till it is dissolved; then add the carbonate of lead, previously mixed smoothly with the remainder of the chloroform, and, having shaken the whole thoroughly together several times, at intervals of half-an-hour, set the mixture aside, and let it stand for ten days, or until the insoluble matter has subsided, and the solution has become limpid, and either colourless or of a slight straw colour. Lastly, decant, and keep the solution in a glass stopped bottle.—*Chemical News*.

"THE MEANS OF FLYING."—M. de Groof, of Bruges, asserts that after 11 years' study he has invented the means of flying in the air in any direction, and only needs money to demonstrate it beyond question. The machine is small, he says, and will enable man to move in the air "with the swiftness of the swallow and the vigour of the eagle." He asks for aid from England.—*Builder*.

THE President of the Federal Government in his message, states that he has favoured the project of an Atlantic cable, and a similar project to extend the telegraph from San Francisco, to connect by a Pacific telegraph with the wire which is being extended across the Russian Empire.

AMONGST the subscriptions forwarded to the Lord Mayor during the past week for the Lancashire Relief Fund was, "A contribution from a portion of the staff of the London District Telegraph Company, £11 12s. 9d." The present Lord Mayor was one of the early promoters of the District Telegraph Company.

To Correspondents.

TYRO.—Your letter is unavoidably postponed until next week.

M. F.—The idea of obtaining static electricity, by means of a band of vulcanized india rubber, or gutta percha, excited by friction, is not new. At the Exhibition of 1851, a machine constructed upon this plan, was shown.

L. C.—The experiment suggested is an interesting one, and worthy of trial.

ERRATUM.—In a paragraph in our last (p. 72) headed, "Iron exhaled from Plants," the word "Ozone" should be substituted for "Iron."

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The Electrician.

VOL. III. No. 60.—DECEMBER 26, 1862.

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ON THE APPLICATION OF A PRINCIPLE OF THERMO-ELECTRICITY TO SUBMARINE TELEGRAPHY.

IN the column specially devoted to "The Student," we have occasion this week to refer to the discovery of Peltier, relative to the effects produced by the passage of a voltaic current through a thermo-electric combination of metals. The suggestion of posssible applications of such discoveries, more especially when these have been generally neglected, or almost overlooked, may frequently be of interest to those who, with the desire for progress, possess the means and the opportunity for experiments upon a scale sufficient to afford practical data. The guess-work of the laboratory, based upon minute results which are susceptible of vast modification, as well as extension, under the conditions of practice, is, nevertheless, often worthy of being registered for the benefit of those who may found upon it a useful superstructure. We will, therefore, proceed to indicate, as clearly and simply as possible, in what manner this discovery might perhaps be applied in the solution of one of the chief problems relating to submarine telegraphy—one which has often engaged our attention—namely, that of obviating the effect of inductive retardation. We have already pointed out one means which we consider would lead to this result, and the title of Mr. LAMING'S present contributions to our columns shows that other endeavours are given in this direction; still, in a matter of this moment and difficulty, there is little danger of creating an *embarras de richesse*, and a suggestion in a new direction may, therefore, be acceptable.

For an illustration, let us take a wire, several hundred miles in length, thinly coated with gutta percha, and laid underground. In signalling through this conductor by any ordinary means, we should of course encounter inductive retardation; we should have to charge the wire before the electricity supplied from the battery would freely transverse the circuit; and, when the signal had been produced, we should have to wait, before transmitting a fresh signal, until the charge had flowed to earth. It is evident that, if the precise moment when the circuit was broken could be indicated at the distant station, we might avoid repeatedly charging the wire; but, under ordinary conditions, the electricity of the charge flowing to earth at the distant end produces, during an appreciable space of time, nearly the same effect as would result from the prolonged contact of the wire with the pole of the battery. Any fresh signal which might be sent before the wire was sufficiently discharged, would, therefore, become blended with the previous one. This, we may presume, is sufficiently understood, together with the fact that the transmission of a signal, when the wire is once charged, occupies but a period of time that is quite inappreciable.

Now it appears tolerably obvious that if we can by any means polarise the conductor, so that, upon the cessation of the battery current producing the effect of polarisation, a current shall tend to pass in the opposite direction, neutralising to a greater or less extent the "current of discharge;" we may expect to be enabled to send signals with greater rapidity, from the fact of the cessation of the battery current being thus indicated, and the transmission of a second current before the wire is discharged becoming then practicable. If, for instance, we raise the conductor from the earth at intervals, say of one mile, and, after cutting the wire, attach a strip of platinum to each of the separated portions, immersing these in a vessel of water; the platinum electrodes will become polarised by the passage of the current, and, on its cessation, will constitute a secondary battery tending to transmit a current in the opposite direction to the current of discharge, and wholly or partially neutralising the latter. When, in fact, the current in one direction became weakened in tension by breaking contact with the source, the tension of the secondary battery would have reached its maximum, and *vice versâ*.

The foregoing arrangement is clearly inapplicable to the case of a submarine line; but the discovery of Peltier, to which reference has been made, would enable us to adopt a somewhat analogous system, presenting but little practical difficulty. It has been found that various samples of copper wire present very considerable differences in their thermo-electric properties, and that a thermo-electric couple of some power may be formed by soldering together two wires of copper of different kinds. If, therefore, our conductor was formed of alternate lengths of two descriptions of copper wire, it would constitute a true thermo-electric series, and the effect of the passage of a current of electricity through this conductor would be to produce the thermo-electric conditions under which a current, in the opposite direction to the primary current, would tend to pass when contact with the battery was broken. Thus, if the voltaic primary, and the thermo-electric secondary batteries were duly proportioned to each other, the secondary effect might be made to neutralise in a sufficient degree the current of discharge, so that the moment of breaking contact would be indicated without the necessity for discharging the wire, and a fresh signal transmitted without becoming blended with the preceding one. It should be observed that the possible value of the suggestion depends in great measure upon the results obtained in experiments which require carefully to be repeated upon a somewhat larger scale than heretofore. We have observed that, upon passing a voltaic current through a combination of bismuth and antimony, the indication when the battery is cut out of the circuit, and the galvanometer substituted for it, is primarily in the opposite direction to that of the voltaic current, although the current subsequently produced, and continuing for a much longer period of time, is in the same direction as that from the battery. Whether the immediate secondary reaction would be sufficient to produce the necessary interval between signals sent with extreme rapidity through a conductor of the construction we have indicated, is a point which appears well worthy of practical examination.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY, BY THE SUPPRESSION OF RETARDING INDUCTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 75.)

APPLICATION OF THE FOREGOING PRINCIPLES OF PHYSICAL ACTION TO THE ELECTRIC TELEGRAPHS, &C.

THE philosophers and manufacturers, each eminent in his particular station, whose names are associated with the enterprise of a new Atlantic Cable, are not to be alluded to without respect; but in the interests of the public—not subscribing capitalists alone, but the whole commercial people—who, in the event of a second failure, will probably long have to wait for a renewal of the attempt, it may fairly be asked if they are prepared with—I will not say a perfect cable—but such an one as will meet their own requirements. Can they even give us one that a seaman may

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handle as easily as a rope; that is as light almost as water, and in which the retardation of signalling shall be almost inappreciable? If they cannot, they ought to satisfy themselves, and be able to give to others cogent reasons for their belief, that the achievement is not practicable in any hands; or the discovery may be made, too late for it to be satisfactory, that our advisers have not been keeping pace with progress. But I must go on with my subject, and leave such matters to whom they more concern, merely remarking that the conclusions to which I am advancing might have been arrived at by any of the readers of the Electrician who had merely worked out what has already been written in its pages.

According to the theory of definite electrical attraction, so far as the preceding parts of this memoir have traced it, a telegraph wire, *supposed to be perfectly insulated in a vacuum of unlimited extent*, could by no possibility receive the smallest quantity of electricity, either as a charge or for conduction; for all the elementary particles of the wire would already have their equivalents, and there would be no external common matter for plus electricity, if upon it, to appropriate to itself by induction.

But the theory, as we even now understand it, is adequate to cause a wire interposed between a plus source and the earth, and surrounded by a vacuum, to receive electricity at one of its ends, and to give up electricity at its other end; because, by reason of the induction (whose nature we now comprehend) there would be, throughout the whole length of the wire, a re-adjustment of the electrical attraction in all its particles, each one in every line of particles virtually surrendering a portion of its natural electricity to its neighbour in the direction of the earth, and simultaneously appropriating to itself an equal quantity naturally belonging to its neighbour in the opposite direction; and this virtual appropriation would be attended by an actual progression of electricity from one particle to another, until it reached the earth, caused by a motive tension equal to the difference between zero of intensity of induction at the earth end and the intensity existing at the other end of the wire. Thus a quantity of plus electricity would pass simultaneously through each section of the wire along its whole length, without the normal proportion attracted by either of the particles of the conductor being at any time deranged; and such inductive pulsations might so rapidly succeed each other, while any electricity remained to be conducted, as to be, so far as our powers of observation are concerned, a continuous stream.

The same inductive action will occasion conduction through the wire, if a plus charge be at one of its ends while the other is in communication with minus conducting matter; because there will be a motive tension acting along the line equal to the difference between the plus intensity at one of its extremities, and the minus intensity at the other.

Again: the wire will act as a conductor if minus conducting matter be at one of its ends and the earth at the other; the motive tension in that case being equal to the difference of minus intensity at one place and zero at the other. But in the first and last cases the conduction would be only half as rapid as in the second of the three cases wherein two equal motive tensions of opposite electrical characters were acting along the wire, both propelling electricity in the same direction; because, the length of the wire being the same, as well as the quantity of electricity simultaneously passing, the resistance would be the same, while the velocities would be as the resistances (*of this theory*) multiplied by the motive tensions.

Instead of the wire being stretched in a vacuum, suppose it to be surrounded by insulating matter of indefinite extent—the atmosphere, for example. Under this new condition, all that under the former one related to conduction along the wire will remain unchanged, but the wire will have fallen under other influences beside those before implicated. If plus electricity of given intensity and in unlimited quantity be presented to the end of a wire so circumstanced, some of it will enter, not to be propagated by induction along it, but to act by induction on the surrounding insulator against an intensity of antagonism less than was before opposed to it, the difference between the resulting and the former antagonisms giving a motive tension for distributing the charge on the wire. If we suppose the further end of the wire to be insulated, the electricity entering will go on increasing in quantity until the intensity of charge upon the wire has risen to equality with that of the electricity at the source, in which state of distribution the motive tension will have expired in the general equilibrium. Imagine the intensity ultimately attained to be represented by the number 16; and the total charge of plus electricity in the wire to have entered in four successive units of quantity; then we are instructed by the electrical law of quantity, that when the second unit of quantity was added to the first unit, the intensity was thereby raised from one to four, and that the accession of the third unit of quantity raised the intensity from four to nine.

The wire being still in immediate contact with a never-failing source of constant intensity, let its further end be uninsulated by being put into communication with the earth. The near extremity of the wire will retain the same plus intensity as before; because the resistance to the entrance of electricity into it is less than the resistance opposed to the escape out of it, by a difference resulting from the resistance opposed by the wire itself; and the far extremity of the wire will participate in the neutral electrical condition of the earth, because the resistance there opposed to the escape of electricity from the wire will be inferior to that which delays its arrival along the wire; therefore, the intensity of induction will progressively decline, from a maximum at one end of the wire to nothing at the other.

The induction consequent upon the limitation of the electrical attraction establishes both conduction and charge; and in doing the latter, it acts from particle to particle in every line of particles of which the conductor may be composed, thus making the conductivity of a wire of given nature to vary with its sectional area multiplied by the square root of the inductive intensity. But the conductivity of a given wire is not constant under varying intensities of induction; a double quantity of electricity acting together upon the near end of a line of conducting particles has a quadrupled intensity, and sets free by induction as much electricity as is held by a quadrupled antagonism of retaining electrical attraction, that is to say, a double quantity. In like manner, a treble quantity acting upon the end of the line liberates a treble quantity, and so on, making the conductivity of a wire to increase in the ratio of the square roots of the intensities of the electricity under conduction. Thus the conductivity of a wire, and the charge upon it, increase in simple ratio with one another, both being caused by the same induction, and opposed by the same antagonism, existing in the one case in conducting, and in the other in non-conducting, matter.

The quantity of electricity presented to the end of a wire may be indefinitely increased without adding to the wire's conductivity; because, the intensity being given, there is only a limited quantity of electricity that can be set free in a given wire by induction. Therefore, the dimensions of the elements in a voltaic series have, relatively to a given wire, a maximum beyond which they cannot be increased with effect. But increased quantity will increase conduction along a wire whenever the electricity presented has been insufficient to keep all its lines of conducting particles in full action at the existing intensity; whence it follows, that, up to a certain maximum, the dimensions of the voltaic elements may be augmented with effect. If we suddenly discharge plus electricity into the end of a wire whose conductivity at the existing intensity is double what is necessary, we shall, of course, leave one half of the conducting capacity unemployed. We might, therefore, by doubling the size of our voltaic elements, when they have only a certain area (while we leave their number in series unaltered) double the quantity of electricity conducted through the wire by each discharge of the voltaic plus pole; and

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if, while in such a case, we doubled the dimensions, we were also to double the number in series, we should a second time double the quantity of electricity sent along the conductor; because the doubled quantity would be poured into the wire at a quadrupled intensity, and that would double its conductivity. In the case, wherein we have a wire with twice the conductivity that is required to pass simultaneously through any point of its length, the plus discharge from a given battery, we shall double the conduction without altering the conductivity if we simply double the number of our elements in series; because, then, by *discharging the pole*, we shall send into the wire a double quantity of electricity, which would thus be made just commensurate with its conductivity. Let this be well understood. One end of a telegraph wire being put to earth, the quantity of electricity, of given intensity, discharged from a voltaic battery into its other end, may be one half only of what it can conduct under that intensity. If we then double the quantity of electricity discharged into the wire by doubling the number of voltaic elements in series, and consequently increasing to a corresponding extent the intensity of the electricity discharged, the double quantity will become conducted under an intensity not exceeding that of the electricity discharged in the first instance; from which we perceive, that in the case of voltaic elements of small size compared to the diameter of the wire, certain additions may be made to their number in series without any increase of motive tension, and, therefore, the resistance being the same, without improvement in velocity. This teaches that, the size of the telegraph wire, and the number of voltaic elements in series being both given, the dimensions of the latter for perfect practice should be so great that no further enlargement of them would add to the quantity, of electricity conducted simultaneously through any point in the line of wire. In comprehending this, it must be borne in mind that it refers to the *simultaneous discharge of accumulated electricity*.

We have seen that the conductivity of a wire is enlarged when the intensity of induction is made greater; we must bear in mind, too, that velocity of conduction is independent of conductivity, being promoted by motive tension only, or a difference between two intensities of induction, or one intensity and zero, and hindered only by resistance, that is to say, in the language of this theory, by the inertia of electricity to motion, and not by any imagined feebleness or absence of conducting power. The motive tension being given, we have to regard it as acting to propel electricity along every line of particles of which a conductor may be composed; the nature of these particles will determine how much electricity each is capable of handing on to the next under any given intensity of induction, but that quantity being given, the rapidity of its passage will be in all cases the same, the velocity being the product of the resistance multiplied by the motive tension, and the resistance for an unit of quantity of electricity being in each line simply as its length. The nature of a conductor being given, the amount of conduction will be as the number of the conducting lines fully in action, multiplied by the velocity in each of them.

When, by doubling, trebling, or quadrupling the number of the series of elements of maximum effective size, we double, triple, or quadruple the quantity of electricity that may be accumulated at the pole of the battery under a four-fold, nine-fold, or sixteen-fold intensity of induction, ready to be discharged into, and conducted along, a telegraph wire, the resistance only increases in the simple ratio of the quantities; but the motive tension increases in the much higher ratio of the squares of the quantities, the far end of the wire being supposed in connection with earth or other large conductor, whose intensity is zero. Therefore, under given circumstances, which now will be well understood, by increasing the number of a voltaic series we may augment velocity of conduction.

The length of a telegraph wire being given, we may, in effect, reduce it to one half, or what is the same thing, we may double the motive tension without increasing the intensity of induction, or the resistance to be overcome, and thus double the velocity. To do this nothing more is needed than to place the zero of intensity at the middle point of the wire, by employing a second battery equal to the first, with its opposite pole in connection with the other end of the wire, the free poles of both batteries being, of course, put to earth.

But, after all, it is not so much velocity of conduction, or the arrival of a large quantity of electricity at a receiving station, that we need to be solicitous about; a small quantity moving through the signalling instruments suffices to actuate them, and quite sufficient for that purpose would arrive in an unappreciable period of time, if we could make the electricity occupy itself with the *induction of conduction* and not with the *induction of charge*; in other words, if we could suppress *retardation*. In the case of the aërial wire it is insignificant; in that of the cable its importance is almost overwhelming. The next question for our consideration must be, how to assimilate the two cases.

ON THE AURORAL PHENOMENA OF THE NORTHERN OCEAN.

BY J. E. WOODS, ESQ., F.R.G.S., LATE SECRETARY TO THE EXPEDITION OF THE "FOX" IN 1860.

The great interest which is attached, not alone by members of the Meteorological Society, but by the world at large, to the no less wonderful than beautiful phenomena known as the Aurora Borealis, has induced me to offer a few observations on this interesting class of natural wonders, based upon the experiences obtained during a five months' cruise in the northern regions in the screw yacht *Fox*, in the latter part of last year. I cannot pretend that these remarks of mine can have any weight in the formation of theories, or any considerable value in a scientific point of view; but I offer them, as I hope they will be accepted by this Society, as a few practical observations which, if they cannot increase the knowledge of, may at least interest the members of the society present here this evening.

Leaving England about the middle of last July, and proceeding direct to the northward of the Shetland Isles, the *Fox* was in the latitude where these phenomena prevail at the period of the year when they are most frequently to be met with, viz., in the months of August, September, October, and November; and consequently those on board had an opportunity of witnessing an unusual number of them. Though possibly auroræ are as numerous in summer as at any other time of the year, practically they are rendered invisible by the almost perpetual daylight which prevails during the months of June and July on the borders of the Arctic circle.

The first aurora was seen on the 19th of August, off the south coast of Iceland, at about 10 P.M. It was neither brilliant nor remarkable, consisting only of a few scattered pencils of light radiating from various parts of the heavens towards the zenith. The sky was partly covered with cirro-cumuli clouds of a light haze structure, which was subsequently found to be almost invariably the case when this class of aurora was visible. The meteor again made its appearance while the *Fox* was at Reikavik, in Iceland, on the 23rd of August, but this time with very great brilliancy, stretching across the sky in bright bands of yellow light, from S.E. to N.W., and moving, as it were, broadside towards the south until it crossed the zenith, where it appeared like the luminous tail of a very brilliant comet, gradually fading away towards the south. The following evening a similar phenomenon appeared about the same time, but its progressive motion seemed to be towards the north. It would be both tedious and unprofitable, however, to enter into a minute description of each individual appearance of the meteor which was so often visible. I shall endeavour, therefore, to divide them into classes, according to the nature of the appearances exhibited. The aurora was visible with varying brilliancy on the 25th, 26th, 27th, 28th, 29th, 30th, and 31st of August, and 4th of September. They belonged, however, to that particular phase of the phenomenon which, for convenience, I shall denominate of the second class. They generally make their appearance in the northern quarter about an hour after sunset, and appear to have their origin in some hazy but dark-coloured cumulo-stratus clouds which usually envelope the horizon, and are scattered about the sky. At first the light only appears like a yellowish phosphorescence at the edge of the cloud, but it soon rapidly spreads itself across

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the sky in an easterly and westerly direction in a broad well-defined band of yellow light, sometimes as much as 150° in length, and from 4° to 7° or 8° in breadth. Gradually detaching itself from the cloud, it advances in a direction always at right angles to the greatest length in a northerly or southerly direction. As it approaches the zenith, the band of light is sometimes bent and distorted, occasionally emitting faint streamers of light. The meteor, after having remained distinct and well defined on the edge, will sometimes fade away into an indistinct luminous haze, through which stars of the first magnitude are visible; at other times it will remain apparently suspended overhead in the zenith as a broad, irregular, luminous cloud, for ten or fifteen minutes, either fading away altogether, or breaking into faint streamers, which radiate for a time to the zenith like a corona, and thus gradually disappear. The second-class phase of the phenomena never appears in a perfectly clear sky (at least as far as my observations go). The light is of a pale-yellowish colour, but sometimes sufficiently strong to cast a considerable shadow. I have never seen it assume the perfect arched form—the chief characteristic of the variety of the meteor presently to be described; indeed, it is more frequently seen as a number of bright irregular patches of light distributed in different portions of the sky, than as the broad irregular band of light already described. I have sometimes witnessed this description of auroral light on wet and misty nights, when a break in the nimbus-clouds allowed the sky to be seen.

Without taking upon myself to form a theory on the causes of the above phenomena, I cannot quite agree with M. De la Rive that every individual aurora witnessed is merely a segment of a circle of electrical discharge, whose centre is the magnetic pole. To my humble judgment, the meteor seems to owe its origin to purely local causes, which may, from the similarity of climate and circumstance, act generally throughout the northern and southern polar regions. Though in very many instances the centres of auroræ were situated in the magnetic meridian, yet such was not always the case, instances having come under my observation where the phenomenon was visible in almost every part of the heavens, the central point of greatest breadth frequently changing its position from north to west, round by south to east, again to north, but sometimes going in a contrary direction in a manner that would defy anything like generalization. The phenomenon bears a striking resemblance to what would probably happen if a slow discharge of atmospheric electricity were to take place between two strata of air or clouds in opposite states of electricity, through such imperfect conductors as a semi-frozen haze or minute suspended crystals of ice, such as is at almost all times to be found pervading the more elevated regions of the higher northern and southern latitudes.

On the 7th of September, when in 64° north latitude, and 28° west longitude from Greenwich, a very brilliant display of what I shall term, for the sake of distinction, a first-glass aurora, took place. The sky was perfectly clear, and the air almost calm. The sea was smooth, and the vessel lay almost becalmed, so that there was an excellent opportunity of studying the meteor. About 7·30 P.M. a slight mass of light made its appearance in the northern quarter of the sky. There were no clouds to be seen, and the moon and stars shone with a brilliancy seen only on a winter's night in the northern regions. The light gradually extended itself to eastward and westward in a slightly arched horizontal line, but at length assumed a curled and undulating form at the western extremity, like a scroll; the extreme length from east to west was about 90°, its perpendicular depth about 5° or 6°, the bend of the arc representing about 6° or 8° of a segment of a circle. The line of the arc, both above and below, seemed to be most perfectly marked. The whole arc consisted of a series of perpendicular pencils of light of all the colours of the spectrum, endowed with extraordinarily rapid motion either to the east or west, crossing and recrossing each other, and producing an effect the beauty of which is unequalled by any other natural phenomenon. But what seems most extraordinary is that, no matter how curved or undulating the arc, or how rapid the lateral motion, the pencils of light always maintain a direction exactly perpendicular to the horizon. In about half an hour from its first appearance, the meteor had advanced in a southerly direction till it stood directly in the zenith. As it approached the latter situation, however, it appeared like looking from beneath at a variously coloured fringe violently agitated by the wind. After fading away and then again reappearing in another direction several times, the meteor gradually disappeared towards morning. This, the most beautiful and characteristic appearance assumed by the aurora, is by no means so common as the second-class phenomenon first alluded to. Its appearance is usually accompanied by a perfectly clear sky, though it is usually seen in that low temperature which is accompanied by an almost imperceptible fall of fine snow-crystals even in the finest weather. The air is usually calm at the time of the continuance of the meteor, though Scoresby, in the narrative of his voyages to East Greenland, mentions the appearance of this description of auroral phenomenon as the almost unerring precursor of a northerly gale. My own observation would almost lead to the same conclusion; but I think it my be accounted for by the fact, that during and previous to a northerly wind in high northern latitudes the atmosphere is usually clear, and upon occasions only when the sky is perfectly serene can the most brilliant phases of auroræ be observed. On the 10th of September a very brilliant exhibition of the second class of the meteor took place about 10 P.M., the central point of which was situated in the magnetic north; it was remarkable as being one of the most brilliant appearances of the second-class phenomenon we observed during the cruise. On the 11th of September a very beautiful aurora of the first-class made its appearance, and after having assumed the forms of the arc and the scroll of variously coloured pencils of light, it disappeared as a beautiful corona of light situated exactly in the zenith. It would be superfluous for me to enter into a description of each individual display of the meteor, which, with the exception of the distinctions already made, are very similar in the appearances they exhibit. Auroræ of the second class were visible on September 14th, 15th, 17th, very bright; 18th, visible all over the sky; 19th, 20th at 3 A.M., and again at 9 P.M., 21st, and 22nd. From this period to the 1st of October the ship was drifting about Davis's Straits in an uninterrupted series of gales of wind; the sky remaining almost always covered with dense nimbus-clouds, from which descended continuously either snow or sleet; so that the auroral phenomena, if present at all, were entirely hidden from observation. On the 1st and 2nd of October, auroræ of the second class were observed moving in a northerly direction. On the 3rd, 4th, and 5th of October, the meteor was observed in great brilliancy, but on all occasions travelling towards the north. On the 6th of October a very brilliant aurora of the first class made its appearance in a perfectly clear atmosphere, sending up coruscations of variously coloured light even beyond the zenith.

The same phenomena were visible on the 7th 8th, 9th, 13th, 14th, 16th, 17th, 18th, 19th, 21st, 23rd, 24th, 25th, of great brilliancy, and exhibiting beautiful play of colours; and the same aspect of the meteor was again visible on the following evening, October 26, but, if anything, with increased brilliancy. The second-class aspect of the phenomenon was visible on the 28th, 29th, 30th, and 31st of October, and the 1st of November. On the 2nd of November, at about half-past eleven P.M., I had an opportunity of witnessing a very remarkable display of the meteor. While returning from the head of Igaleko Fiord in a boat to Juleanhaab, South Greenland, we encountered a very sharp gale of northerly wind which prevented our reaching the ship. When about half a mile distant from Store or Great Island, in the Fiord, I distinctly observed a very bright auroral light mingled with the snow-drift which was whirled from the top of a mountain on the island by the force of the gale. When we reached within some 300 or 400 yards of the base of the mountain, which was under 1,000 feet in height, I distinctly saw the auroral arc detach itself from the snow-drift, and display itself between me and the summit of the mountain, about 200 feet below, the latter emitting a very bright yellowish phosphorescent light. I could detect no sound, though the phenomenon could not have been more than a few hundred yards from me; but even if there had been any sound, I do not think it could have been heard, as the wind was blowing with such extreme violence at the time. The appearance was observed by our Esquimaux crew, who regarded it with great fear, and gave me to understand that it was the sign of a violent storm from the north—a prediction which certainly was verified before the morning. The aurora was again visible on the evenings of the 3rd, 4th, 5th, 6th, 7th, 8th, 12th, and 13th of November, after which, as the 'Fox' proceeded south of the 53rd degree of northern latitude, the phenomenon was seen no more. Thus, in the three months from 13th of August to the 13th of November auroræ were observed to a greater or less extent on fifty-seven nights, sometimes two and three exhibitions of the meteor taking place in a single evening.

Now as to the causes which lead to the development of the aurorat phenomenon in the northern and southern regions, I cannot help entertaining a view which differs considerably from that which is generally received. That the light is caused by atmospheric electrical discharge taking place between minute crystals of ice, I think all who have seen the phenomenon must admit; but at the same time I think this discharge is a purely local one, and takes place between two clouds, or between two strata of air in opposite states of electrical

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tension. That it is common to observe two or even three strata of air in different physical and possibly also electrical conditions, all who have visited the northern regions must have observed. Indeed, the phenomenon so frequently remarked by Scoresby, of terrestrial objects being seen reflected in the air in the northern regions, is due to this cause alone. Is it not possible that these plates of air may, in a climate so very unfavourable to conduction, become so charged by opposite electricity as to establish an equilibrium by a partially disruptive discharge through the minute snow-crystals which are usually found floating in the atmosphere in very cold climates? Though I preserved notes of upwards of sixty auroræ, in no instance did I remark the least sound; nor among all the residents of Iceland and Greenland with whom I conversed could I find any one who had himself heard any sound proceeding from the meteor, though the belief seemed very general that the sound was sometimes heard. There are many other interesting facts connected with this subject which came under my notice, but I fear that by relating them all to you this evening I should be occupying too much of your time.—*Report of the British Meteorological Society*, 1861.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1810—BYWATER, John.—

[An Essay on the History, Practice, and Theory of Electricity. By John Bywater. London; printed for the Author, by Davidson, Old Boswell Court; sold by J. Johnson and Co,, 72, St. Paul's Churchyard, 1810.]—8vo., 127 pages, plates.

1814—SINGER, George.—

[Elements of Electricity and Electro-Chemistry. By George John Singer. London: printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster Row; and R. Trephook, St. James' Street, 1814.]

1817—BAIN, William.—

[An Essay on the Variation of the Compass, showing how far it is influenced by a change in the direction of the ship's head, with an exposition of the dangers arising to navigators from not allowing for this change of Variation; interspersed with practical observations and remarks. By William Bain, Master Royal Navy. Edinburgh: printed for William Blackwood, Prince's Street; and John Murray, Bookseller, of the Admiralty and Board of Longitude, Albemarle Street, London, 1817.]—8vo., 140 pages, plate.

1817—BOMPASS, Charles Carpenter.—

[An Essay on the Nature of Heat, Light, and Electricity. By Charles Carpenter Bompass, Barrister-at-Law. London: printed for T. and C. Underwood, 1817.]—Chapter III. on Electricity.

1818—BOSTOCK, John.—

[An Account of the History and Present State of Galvanism. By John Bostock, M.D., F.R.S., &c. London: printed for Baldwin, Cradoch, and Joy, Paternoster Row, 1818.]—8vo., plates.

1820—BARLOW, Peter.—

[An Essay on Magnetic Attraction, particularly as respects the Deviation of the Compass on Ship Board, occasioned by the local influence of the guns, &c., with an Easy Practical Method of observing the same in all parts of the world. By Peter Barlow, of the Royal Military Academy. London: printed for J. Taylor, Architectural Library, Holborn, 1820.]—8vo.

1820—GREGORY, D.D.—

[Lectures on Experimental Philosophy, Astronomy, and Chemistry, intended chiefly for the use of students and young persons. By G. Gregory, D.D., late Vicar of West Ham, Domestic Chaplain to the Lord Bishop of Llandaff. In Two Volumes; Second Edition revised and improved. London; printed for Longman, Hurst, Rees, Orme and Brown, Baldwin, Cradock, and Joy, Scatchand and Letterman, G. and W. B., Whittaker and Sherwoods, Nealy and Jones, 1820.]—Small 8vo.. 670 pages, plates. Lectures 1, 2, and 3, Electricity and Magnetism.

1820—HACHETTE & AMPERE.—

[Sur les Experiences Electro-Magnetique de MM. Œersted et Ampère. Par M. Hachette. (Extrait du Journal de Physique, Septembre, 1820.)—Note sur un Memoire lu à l'Académie Royale des Sciences, dans la séance 4 Decembre, 1820. Par M. Ampère. (Extrait du Journal de Physique du mois de Septembre, 1820.] De l'Imprimerie de Huzard-Courcier, Rue des Jardines, No. 12.

1821—CUTHBERTSON, John.—

[Practical Electricity and Galvanism; containing a series of experiments calculated for the use of those who are desirous of becoming acquainted with that branch of science. Illustrated with nine copper plates. By John Cuthbertson, Philosophical Instrument Maker, and Fellow of the Philosophical Societies of Holland and Utrecht. The second edition, with corrections and additions. London: Printed for J. Callow, medical bookseller, 16, Princes Street, Soho, 1821.]—8vo., 294 pages.

1822—ROBISON, LL.D., John.—

[A System of Mechanical Philosophy. By John Robison, LL.D., late Professor of Natural Philosophy in the University of Edinburgh. With Notes by David Brewster, LL.D., F.R.S., &c. In four volumes, and a volume of plates. Volume 4 contains voluminous chapters on Electricity and Magnetism. Edinburgh: Printed for John Murray, London, 1822.]

1823—RONALDS, Francis.—

[Descriptions of an Electrical Telegraph, and of some other electrical apparatus. By Francis Ronalds. London: Printed for R. Hunter, 72, St. Paul's Churchyard, 1823.]—8vo., 84 pages.

One of the most interesting and remarkable books connected with telegraphy. Francis Ronalds may be justly considered the first projector and inventor of an electric telegraph.

1824—BIOT, J. B.—

[Précis Elementaire de Physique Experimentale. Par J. B. Biot, Membre de l'Académie des Sciences. De l'Ouvrage destiné à l'Enseignement, publié par Arrête de la Commission d'Instruction Publique, en date du 22 Fevrier, 1817. Troisième édition. Tome 1 et 2. A Paris: chez Deterville, Libraire, Rue Hautepeille, 1824.] —2 vols., 8vo., 1358 pages, Illustrated.

1825—FERGUSON, James, F.R.S.—

[Lectures on Electricity. By James Ferguson, F.R.S. A new edition, corrected, with an appendix adapting the work to the present state of science, by C. F. Partington, author of a descriptive and historical account of the steam engine, and one of the Lecturers at the London, Russel, and Metropolitan Institutions, Mechanics' Institutes, &c. &c. London: Published by Sherwood and Co., Paternoster Row, 1825.]—(First edition published in 1770). 1 vol., 8vo.

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1825—BARLOW.—

[On the Laws of Electro-magnetic Conduction, 1825.]—Pamphlet.

1827—CUMMING, James.—

[A Manual of Electro Dynamics, chiefly translated from the Manuel d'Electricté Dynamique, or treatise on the mutual action of electric conductors and magnets, of J. F. De Monferrand, with notes and additions, comprehending the latest discoveries and improvements. By James Cumming, M.A., F.R.S. and G.S ; late President of the Cambridge Philosophical Society ; and Professor of Chemistry in that University. Cambridge: Printed by J. Smith, printer to the University, for J. and J. J. Deighton, Cambridge, and C. and J. Rivington, London, 1827.]—8vo., plates.

1827—GREEN, Jacob.—

Electro-Magnetism, being an arrangement of the principal facts hitherto discovered in that science, with plates of the apparatus, By Jacob Green, M.D. Philadelphia: Judah Dobson, 108, Chesnut Street, 1827.]—12mo., 210 pages, plates.

1828—GREEN, George.—

[An Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism. By George Green. Nottingham: Printed for the Author, by T. Wheelhouse. Sold by Hamilton, Adams, and Co., 33, Paternoster Row; Longman and Co.; and W. Joy, London; J. Deighton, Cambridge; and by S. Bennett, H. Barnett, and W. Dearden, Nottingham, 1828.]—4to., 72 pages.

One of the most important works ever written on Electricity.

1828—HARRIS, W. S.—

[Experimental Inquiries on Electrical Accumulation. By W. S. Harris. From the Transactions of the Plymouth Institution. Plymouth: Rowe, 9, Whimple Street, 1828.]—Pam., 8vo., 53 pages, plates. Dated at the end, "Plymouth, Nov. 17, 1825."

1828—WATKINS, Francis.—

[A popular sketch of Electro-Magnetism, or Electro-Dynamics; with plates of the most approved apparatus for illustrating the principal Phænomena of the Science, and outlines of the parent sciences Electricity and Magnetism. By Francis Watkins, curator of Philosophical Apparatus in the University of London. London: printed for John Taylor, Bookseller and publisher to the London University, 30, Upper Gower Street; Deightons, Cambridge; Parker, Oxford; and Watkins and Hill, Philosophical Instrument Makers, 5, Charing Cross, 1828.]—8vo., 83 pages, plates.

1829—POPE, William.—

[The Triumphal Chariot of Friction, or a Familiar Elucidation of the Origin of Magnetic Attraction, &c., &c. By William Pope, Inventor of the Patent Dipping Needle Mariners' Compass. &c., &c. With plates from drawings made by the Author. London: printed for the Author, and sold by him at 11, Ball Alley, Lombard Street; and may also be had of every respectable Bookseller, 1829.]—1 Vol., 4to, 110 pages, copiously illustrated.

1829—EXLEY, Thomas.—

[Principles of Natural Philosophy, or a new theory of Physics founded on Gravitation, and applied in explaining the general properties of matter, the Phenomena of Chemistry, Electricity, Galvanism, Magnetism, and Electro-Magnetism. By Thomas Exley, A.M., &c. London; printed for Longman, Rees, Orme, Brown, and Green, Paternoster-Row; and B. Barry, Bristol, 1829.]—8vo., 478 pages. Pages 163 to 478 on Electricity, Magnetism, &c.

ON MAGNETIZING STEEL NEEDLES BY THE CURRENT OF A LEYDEN JAR.

BY DR. PAALZOW.

FROM the fact that a steel needle, by the discharge of a Leyden jar, may be abnormally magnetized, that is to say in a direction contrary to that required by Ampere's rule, Savary and Helmholtz concluded that there must be an alternating motion of the electricity in the circuit of a Leyden jar. I imagined I had found in the phenomena of Geissler's tubes a means by which it could be decided whether the discharge was simple or alternating; with its help it could be shown whether the occurrence of abnormal magnetism actually depended on a change in the direction of the current.

The proof could be given by magnetizing with currents which, according to the indications of the tubes, had a single direction. Under these circumstances only a normal magnetism should be observed; and when abnormal magnetism occurred, the indications of the tube ought to be those of alternating discharge.

I accordingly induced Dr. von Liphard to investigate the magnetizing of steel needles by the current of the battery. He found that, so long as the Geissler's tubes indicated with certainty a single discharge, abnormal magnetism was never observed; and that whenever abnormal magnetism occurred, the luminous phenomena indicated alternating discharges.

But the proof that abnormal magnetism is to be ascribed to currents in opposite directions may be drawn from the needles themselves. Wiedemann, in his investigations on the magnetization of steel bars (Poggendorff's *Annalen*, vol, c. p. 241), has given a method for deciding whether a magnetic or unmagnetic needle was previously magnetic or had a different magnetism. It appeared to me possible to show by the aid of these means that the abnormally magnetized needles had been previously normally magnetized by the same discharge of a battery, and that in fact a demagnetization had actually taken place.

In common with Prof. Wiedemann I commenced these investigations, and have since continued them. Of the modes of testing, that was chosen which is described in the above treatise in the following words:—

"If the magnetism in a steel bar had been partially or totally withdrawn, or even completely reversed by a current opposite in direction to the original magnetizing current, it regained, on being struck, a part of its first magnetism. Hence it is impossible in this way to prepare an unmagnetic bar, which by agitation becomes magnetic. In this case the bar can of course be placed at right angles to the magnetic meridian, and thus withdrawn from the influence of the terrestrial magnetism."

In these experiments it was shown that perfectly unmagnetic needles, which also remained unmagnetic when they were struck before being magnetized, assumed normal magnetism when struck with unmagnetic substances, after they had been abnormally magnetized by the discharge of a Leyden battery. In these experiments the circuit consisted of short good conducting wires, between which a Riess's air thermometer and a short magnetizing spiral of 27 turns were coiled.

From Wiedemann's experiments, needles in which the magnetism could be increased or reversed by striking must have been previously magnetized in the opposite direction; only one discharge of the battery had magnetized the needles, and therefore these discarges must have taken place in opposite directions. Hence it appears to me justifiable to regard the occurrence of abnormal magnetism as a sign of the alternating direction of the discharge of the Leyden jar.—*Monatsbericht der Akademie zu Berlin*, February, 1862.

NOTE ON THE LIMIT OF THE CHARGE OF CONDENSERS.

BY M. GAUGAIN.

The charge of any given condenser placed in connection with the ground depends on the greater or less time during which the action of the source is continued; at least this is the case when the dielectric is a solid body. Hence in the case of solid dielectrics, the ex-

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pression representing the quantity of electricity accumulated on the armatures of a condenser ought to be a function of the time during which the condenser is placed in connection with the source. But although, theoretically speaking, the state of equilibrium ought only to be established after the lapse of an infinite time, in point of fact the increase of the charge becomes inappreciable after a certain number of hours, which is never very considerable when the dielectric is not very thick; hence it might be proposed to determine experimentally the value of the greatest charge which a given condenser could take when the action of the electrical source is infinitely prolonged. The determination of this limiting charge presents no particular difficulty; it only requires considerable time, seeing that a single experiment may last several days.

I generally worked with small insulating discs with plane surfaces, and with plain metallic armatures applied directly on the solid dielectric.

I first endeavoured to ascertain the relation between the limiting charge and the thickness of the dielectric, and I found that this thickness is quite indifferent. This result appeared to be opposed to that obtained when the air is taken for a dielectric; in this case I have already shown that the charge is almost inversely as the thickness of the layer of air, at least when this thickness is very small in reference to the surface of the armatures. But it is not difficult to explain this divergence, from considerations which I have presented in a previous note. In fact, an air condenser is a simple condenser, while a condenser with a solid dielectric is really a battery by cascade. The imaginary solid dielectric (sulphur, shell-lac, or gutta percha) is a true conductor. The dielectric is really the air which separates the insulating disc from its armatures. Regarding matters in this light, it will be understood that the thickness of the insulating disc between the armatures ought not to influence the limiting charge, but only the time necessary to obtain equilibrium; and, in fact, to obtain a limiting charge, the time required is longer as the insulating disc is thicker.

Secondly, I compared fulminating panes of the same dimensions, formed of different dielectrics (sulphur, shell-lac, &c.), and I found that the limiting charge was the same for all bodies; so that it would be necessary to say that they have all the same inductive capacity —if the use of this phrase (which, as I think, does not express a distinct property) ought not to be completely abandoned.

In all the experiments of which I have hitherto spoken, the armatures of the fulminating panes were directly applied to the insulating disc; in this manner different insulating discs could be compared with each other: but insulating bodies could not be compared with metals. To establish this comparison, I modified the arrangement of the fulminating panes. I separated the metallic armatures from the insulating disc by small layers of air of constant thickness. By working in this manner, and using as intermediate discs metallic plates of different thicknesses, I found that this thickness does not perceptibly influence the charge of the condenser, at least so long as this disc is very thin as compared with the diameter of the discs. I found, secondly (and this point appears to me important), that the limiting charge is not modified by substituting a metallic disc for an insulating one. In the case of an insulating disc, the limiting charge is only obtained after the lapse of a considerable time, varying with the nature and thickness of the insulator, while with the metallic disc the limiting charge is established into an inappreciable time.

When the intermediate disc is an insulator in immediate contact with the armatures, the limiting charge depends, as I have just said, neither on the nature nor thickness of the insulating body; but it may vary considerably with another element, which has not hitherto been taken into account, and which is really an important element; this is the *external resistance* of the insulator. This resistance arises almost entirely, if not quite, from the small layer of air always interposed between the insulating disc and its armatures, even when the surfaces have been planed with the greatest care; and it varies singularly with the hygrometric state of the surrounding air. This circumstance makes the experiments in question somewhat delicate. In fact, from what I have said, when two fulminating panes, formed from insulating discs of different nature and thickness, are compared, it is indispensable that they be placed in the same hygrometric conditions.

From the whole of my researches, it appeared to follow that insulating solid bodies, submitted to the influence of electricity, behave exactly like metals, and consequently the inductive capacity is not distinct from the conductibility. I am not ignorant that the conditions under which I experimented are extremely different from those indicated by the illustrious philosopher who propounded the notion of inductive capacity. Instead of charging to saturation the Leyden jar with which he worked, Mr. Faraday charged it as rapidly as possible, so as to remove the effects of the conductibility of the dielectric, which he only considers as a disturbing cause. But this mode of view does not seem to me to rest on decisive reasons. I have limited myself, in the research of which I am giving the general results, to considering the permanent state; Mr. Faraday, on the contrary, has only occupied himself with the variable state; but it is difficult to admit that the distribution of electricity should not be ruled by the same principles in both cases. I propose to revert to the phenomena of the variable state.—*Comptes Rendus*, Sept. 8, 1862.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d. to 2s. 2d.	per lb.
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Java	1s. 5d. to 1s. 6d.	„

GUTTA PERCHA.

Fine	2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	„
Ordinary Reboiled	1s. 0d.	„

December 24, 1862.

WM. KIRKMANN,
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TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	58 to 63	———
20	Do. B 7 per cent. till 1862 .	—	———	———
Stock	Electric Telegraph . .	100	98 to 100xn	99
25	Do. New . . .	—	———	———
5	London District Telegraph .	4¾	4 to 3 dis.	1¼ ⅜
10	Mediterranean Extension Tel.	all	3½ to 4	———
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ½	———
1	Do. registered . . .	all	⅜ to ½	———
10	Do. „ . . .	all	4 to 6	———
2	Telegraph to India . .	1	⅝ to ¾ dis.	———
5	United Kingdom Telegraph .	3	¼ dis. to ¼ pm.	———

ON THE EMPLOYMENT OF THE RATAN CANE AS AN EXTERNAL COVERING FOR SUBMARINE CABLES.

(From *The Engineer.*)

HITHERTO iron, steel, or hemp, alone or in combination, have been the only materials used for giving strength and protection to submarine cables. An addition to these substances has recently been made in the ratan cane, which grows so plentifully in Borneo, Ceylon, Singapore, and China. Several specimen lengths of cable, wholly or partially sheathed with this material, were exhibited at the International building at Kensington. The suggestion, which is due to Mr. Charles S. Duncan, appears to have been taken from the "dwellers upon water" among the Chinese and Malays, who invariably employ the cane, twisted into ropes, for anchoring or making fast their junks upon the banks of rivers and canals. The lightness, strength, and moderate flexibility of the cane, and especially its property of remaining unaffected by water during a great number of years, render it peculiarly adapted for this purpose. The same qualities must obviously, to some extent, conduce to render it applicable as an external covering, giving strength and protection to the insulated wire in telegraph cables. When we add that it is to be obtained in inexhaustible quantities and at a cheap rate, in lengths, of uniform gauge, of 50ft. and upwards;* that joints may simply and efficiently be made as strong as the cane itself; that it does not elongate under tension or contract in water; and that it has been shown to

* According to the best writers on oriental botany, the ratan (*Calamus ratang*) is a spontaneous production, growing from 400ft. to 600ft. in length, and, when cut at proper seasons, contains a large proportion of silica both in the exterior rind and internal fibre.

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withstand great hydraulic pressure; the presumption in favour of this application of the material cannot but be strengthened.

It appears to be now generally admitttd that heavy iron-covered wires are unfit for the purposes of deep sea telegraphy. The principal grounds for objection were very definitely stated, so far back as May, 1859, by the late Mr. Robert Stephenson, in a letter addressed to Sir Stafford Northcote at the Treasury Board:—"However advisable, and, indeed, indispensable, iron may be for shallow waters, it is certainly not well adapted for great depths, and, indeed, quite inapplicable to such a depth as that contemplated. In fact, a wire rope of such a length will do little more than support its own weight; and its strength is therefore evidently insufficient to meet the accidental strains to which it must necessarily be subjected. Iron is also a material which is liable to rapid destruction in sea-water from rust, and steel is liable to a similar objection, although it is quite admissible as regards strength." More recently, in May of the present year, the same opinion was expressed by Mr. Siemens in a lecture delivered before the Institution of Civil Engineers:—"The outer covering of cables, as hitherto constructed," says Mr. Siemens, "is certainly the least perfect part. An iron sheathing is very necessary to protect the insulated core in shallow water; but for cables in more than thirty or forty fathoms water the iron sheathing is an element rather of weakness than of strength. It renders the cable ponderous, its shipment expensive, the paying out risky, and repairs impossible, owing to the difficulty of raising a heavy cable from a great depth under any circumstances, and the absolute impossibility of doing so after corrosion of the iron wire has made some progress."

Generally speaking, the best form of cable for laying in deep water, so far as its mechanical qualities are involved, is that which, *in water*, will support the greatest number of fathoms of its own length, or which possesses the lowest specific gravity in proportion to its strength. "A perfect cable for a deep sea," says Mr. Robert Stephenson, in the communication quoted above, "should be of a specific gravity but very little greater than that of water, so that it could be paid out with the same ease as a common log line. Such a cable would entirely obviate the great strain to which all heavy deep sea cables must be subjected in laying them out—a strain which has so often proved fatal, and is, indeed, the great source of all the difficulties on the subject."

That these considerations have been generally ignored is well known to those who have followed the history of submarine telegraphy. A cable of very low specific gravity is even now regarded by many as impracticable in laying, more especially where cross currents are likely to be encountered. In a communication lately addressed by Mr. Hoskyn, R.N., to the Atlantic Telegraph Company, the difficulties arising from this cause with light cables are, however, stated to be purely imaginary, and this appears to be the general opinion of seamen, as well as of many telegraph engineers, upon this point.

The specific gravity of a cable covered with ratan only has been found to be 1·059, "but very little greater than that of water." This cable is said to have supported a strain of more than 2½ tons, which gives a tensile strength greater than that of the best combinations of steel and hemp in which a low specific gravity has been aimed at. Where a higher specific gravity than that above given may be required, a combination of the ratan with iron or steel wires in the spandril spaces appears likely to answer every purpose. This combination allows of the distribution of the strain equally upon both materials, and when the specific gravity of 1·54, or higher, has been reached, there is yet immense strength in proportion to the weight. Again, the iron or steel wires being required only to support their own weight, leaving a considerable margin of strength in the other material of the sheathing, the gradual corrosion to which it is exposed is comparatively of little moment in regard to any subsequent operations for raising and repairing the cable. The breaking strain of a cable cased with cane and steel wires, weighing 1 ton 7 cwt. per knot, and of a diameter of 1 in., was found to be six tons.

There is some necessity for new suggestions, and of active measures in testing their value, in a branch of telegraphy which, so far as the mechanical conditions in cables are concerned, has been allowed to remain almost in *statu quo* from the period of Mr. Brett's early experience. The depreciation arising from the corrosion of iron sheathing, in the cables of the Electric and International Company alone, has been estimated at £8,000 per annum; and it is asserted that in many cases the insulated core has received injury in the process of sheathing with heavy iron wires. We cannot fail to perceive the impossibility of ever raising—if not, indeed, of submerging without injury—the iron-covered cables in deep water; and we may anticipate, therefore, that a more efficient and, perhaps, cheaper method of protection will ultimately be adopted. The ratan cane of China appears well adapted for the purpose in view, and promises to be a valuable addition to the *matériel* of submarine telegraphy.

The Student.

Thermoscopic Galvanometers.

Although a carefully made astatic galvanometer of the ordinary construction is, when coiled with stout wire, sufficient for all experimental purposes in thermo-electricity, the following instrument, constructed by Dr. Locke, merits a description. The coil was composed of a ribbon of copper about fifty feet long, one-fourth of an inch wide, and one-eighth of an inch thick, weighing between four and five pounds. This was wound closely, in parallel turns, on a circular piece of board eleven and a half inches in diameter and half an inch in thickness, composed of several pieces, so as to be readily withdrawn from the interior of the coil when wound. The copper ribbon was made to enclose the whole of the wooden disc, with the exception of two opposite segments of about ninety degrees each; on withdrawing the disc, a cavity of nearly its own shape was left, in which the needle was placed.

A thin coating of varnish upon the copper ribbon is sufficient, with electricity of such low tension as that from thermo-sources, for all purposes of insulation; indeed, in Dr. Locke's instrument, the copper was left uncovered, the several turns being merely separated at their ends by veneers of wood. The coil was supported horizontally within a wooden ring, furnished with brass feet and levelling screws, and surrounded by a brass hoop with a flat glass cover. In the centre of the latter was a small aperture, within which was inserted the extremity of a brass tube for the suspension of the needle by means of a fibre of silk. The astatic needle was composed of two magnets, eleven inches in length, one-fourth of an inch in width, and one fortieth of an inch in thickness. The lower magnet played within the coil, and the upper one above it; a thin white dial being placed over the latter, to perform the office of a conspicuous index underneath the glass.

With a single thermo-electric couple, composed of a disc of bismuth as large as a sixpence, soldered to a corresponding disc of copper, the warmth of the finger was sufficient to impel the needle through 180°; so that, by reversing the connections at every half turn, a continued revolution of the needle was obtained. When the copper element of the couple was blackened, to increase the absorption of heat, and placed in the focus of a reflector, the same effect was produced by means of a ball of metal heated below redness, and placed in the focus of an opposite reflector, at the distance of twelve feet.

Production of Heat and Cold in Thermo-electric Combinations.

The passage of a current of electricity from the voltaic battery through any thermo-electric combination produces the conditions under which a thermo-electric current in the opposite direction may subsequently occur. When the voltaic current passes from the negative to the positive element, from antimony to bismuth, for instance, heat is evolved at the surface of junction; while the passage of the current from bismuth to antimony determines the absorption of heat or the production of cold. This important and interesting fact, discovered by Peltier, has been strikingly verified by Lenz in the following experiment:—A bar of bismuth was soldered to one of antimony at right angles, and a cavity was made at the point of crossing. In this cavity was placed a drop of water previously cooled to nearly 32°. Upon bringing the positive pole of the battery into contact with the bismuth, and the negative pole into contact with the antimony, the water *was rapidly frozen*. Upon reversing the contacts, the temperature of the water becomes raised, as may be seen by its more speedy evaporation, or by means of a small thermo-couple. The production of cold as an electrical phenomenon may be new to many of our readers; but in any case this most beautiful example of reciprocal effect must prove an inducement to research in a branch of science which enables us thus to command the agencies of nature.

ON A NEW PREPARATION OF PURE OXYGENATED WATER.

BY M. DUPREY.

By passing a very rapid current of pure carbonic acid into distilled

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water, and adding at intervals binoxide of barium, perfectly pure oxygenated water is obtained.

When the quantity of carbonate of baryta is sufficiently large to obstruct the passage of the gas, the clear liquid, containing all the oxygenated water, must be decanted, and the current of carbonic acid again passed into it. As soon as more binoxide of barium is thrown in, a fresh quantity of oxygenated water is formed. In this way we obtain water strongly charged with perfectly neutral and pure oxygenated water, which can be concentrated under an air-pump. Care must be taken to maintain a sufficiently rapid current of carbonic acid, so as to be always in excess of the small and gradually added quantities of binoxide of barium, which must, moreover, be finely powdered, as large pieces escape decomposition.

In all my experiments, the carbonic gas has been carefully washed by passing through flasks containing carbonate of lime. It is then evident that to its action alone is to be attributed the production of oxygenated water; and the experiment shows, moreover, that it can be obtained as well with oxacids as with hydracids.

The best re-agent I have been able to find for oxygenated water is decidedly permanganate of potash, which, when poured into water containing even a very small portion of oxygenated water, disengages all its oxygen. This body serves to estimate oxygenated water, the phenomena of decoloration being very apparent.—*Comptes-Rendus.*

THE ATLANTIC TELEGRAPH.

(From *The John Bull.*)

THOSE who have built their hopes of the promotion of goodwill between man and man on the completion of the great work projected by the Atlantic Telegraph Company, will be rejoiced to learn that active measures have once more been adopted for the purpose of reducing this magnificent conception to a practical fact. We do not venture to express any decided opinion of our own as to the probable advantages of the undertaking in a commercial point of view. Nevertheless the privileges secured to the holders of the new preferential capital about to be issued are amply sufficient to redeem the project from a charge of Quixotism even in the eyes of the most timid speculator. No preliminary expenses are incurred, such as those heavy guerdons which we have seen paid in several instances to the "promoters" of new banks and other companies; while the confidence of the directors in the scheme is shown by their undertaking that the deposits payable on allotment shall be returned in case the amount of £300,000 is not subscribed. This confidence is fully warranted by the scientific advice under which the directors are acting, the value of which may be estimated from the well-known names forming the Consulting Committee. Under these circumstances the company is quite right in appealing to the general public by fixing their new shares at the popular amount of £5, and we anticipate a large accession to their shareholders from the desire which Englishmen would naturally entertain of promoting such an enterprise, even irrespectively of the fair prospects which it holds out as an investment. Those prospects may be said to amount to a certainty, if the cable holds. Now, when the cable so unfortunately parted some time ago, there were plenty of wiseacres who assured us that it was perfectly chimerical to suppose that a submarine telegraph ever could be depended upon to last even from one day to another. Some chimeras, however, do somehow or other find their way into the domain of matter-of-fact zoology; and telegraphic communication under the sea would seem to be one of them, fifty-one ventures of this kind having been made, forty-four of of which have been perfectly successful. Of these successful cables we understand that thirty-one were manufactured by Messrs. Glass and Elliott, who undertake to subscribe and pay up in cash to the present new capital the sum of £25,000; and will allow this company to pay weekly for the materials used and labour employed about the making and laying of it, charging no profit thereon, and nothing for the use of their works and machinery, nor for their personal services during the progress of the manufacture, nor until the cable is completely successful. The various submarine cables laid down by this firm in various parts of the world, and now employed in transmitting messages, extend to an aggregate length of 3,929 miles. The largest of these is that from Malta to Alexandria, which is 1,535 miles long, and has now been at work for a year; several of their cables, however, have been used without interruption for periods of six, seven, and eight years. What we have said will show, we think, that the price of the company's shares is not to be looked on as money rashly ventured: but every Englishman, whether he participates in the enterprise or not, must take a warm interest in its success, not merely as a work of great national importance but as one which concerns the whole human race. In the midst of the vague and frothy paragraphs of President LINCOLN'S message, future ages, we may hope, will point to one plain and business-like sentence as the anticipation of a great reality:—"I have favoured the projects for connecting the United States with Europe by an Atlantic telegraph, and a similar project to extend the telegraph from San Francisco, to connect by a Pacific telegraph with the wire which is being extended across the Russian empire."

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

TRAIN SIGNALLING.

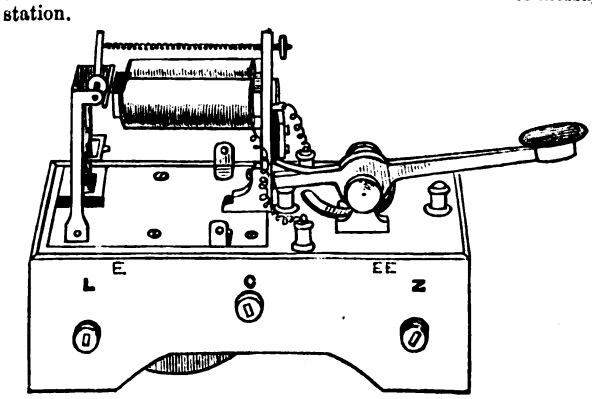
SIR,—As various methods of train signalling by the aid of electricity have, from time to time, been brought forward in your journal in connection with new or modified apparatus, the following account of a single-stroke electro-magnetic bell, which I have had constructed for adoption on the line of railway on which I hold an appointment, may interest some of your readers, and prove useful to those who are in search of an efficient, and, at the same time, economical plan of signalling trains.

This bell, of which a sketch and short description are given below, is adapted to telegraph trains between station and station on a similar plan to that introduced many years ago by Mr. C. V. Walker, F.R.S., on the South Eastern Railway. The practical advantages of this method appear to me to be:—

1st. Great simplicity, so that an ordinarily intelligent man may acquire it in an hour.

2nd. Ample security for all traffic on a main line properly provided with signal stations, signal men, and books for recording the signals sent and received.

3rd. Economy in first cost and subsequent working—from the fact that one wire only is required for both lines, and that the bells being of simple construction are inexpensive in themselves, and can be worked from the same batteries as the instruments used for the transmission of messages at the station.



The bell, as will be seen from the above sketch, is designed both to send and to receive an electric current, and, as I find in practice, rings well with two ten-plate sulphate batteries (Muirhead's) in a circuit of seven miles.

The helical spring and screw placed over the coils renders it very easy to adjust the hammer, to meet the practical difficulties of reduced battery power or an impaired insulation through bad weather, &c.; and the addition of a lightning conductor, which is fixed underneath the tapper, affords complete security to the coil from atmospheric electricity.

A cover screwed down to the stand secures the more delicate parts of the instrument from being touched, as well as from dust, &c.

In practice I find ten distinct signals sufficient for all the requirements of the line; these are:—

One blow for all *up* stopping and goods trains, *out i. e.* about to leave the station.

One blow given and acknowledged twice for all up special and non-stopping trains, or engines out.

Two blows for all *down* stopping and goods trains *out.*

Two blows given and acknowledged twice for all down special, &c., trains *out.*

Three blows for all trains or engines *in.*

The in signal not to be given until the station is clear, and ready to receive another train on the same line.

Four blows, a special signal at junctions, &c.

Five blows, *danger* signal, to stop every thing on the line, to be used in all cases of obstruction.

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Three blows, given and acknowledged twice, the *all clear* signal.
Seven blows for calling attention to the speaking instrument.
Eight blows, signal to test the bells.

As it is evident that at each intermediate station two of the bell instruments are required, viz. one for the up side and one for the down side of the station, I have distinguished between the up and down instruments by having the bells of different tones, the former having an acute, and the latter a deeper tone. Gongs might also be used, but the sound from gongs does not penetrate so far, on which account they appear to be less advantageous than bells for the above purpose.

I must not omit to add that I have received the most intelligent aid from Mr. Bryant, in carrying out the construction of these bell instruments, of which he has supplied a considerable number for our line.—I am, sir, your obedient servant, FRANCIS RUDALL.

London, Chatham, and Dover Railway, Telegraph Department, Victoria Station, Pimlico, Dec. 16, 1862.

ATLANTIC TELEGRAPH.

To the Editor of THE ELECTRICIAN.

SIR,—Curiosity impelled me to attend the meeting of the Atlantic Telegraph Company on the 12th instant, when the Chairman, amongst other statements, made the astounding one that gutta percha had been submitted to a pressure of seventy thousand tons on the square inch. I would willingly leave such assertions to speak for themselves. What I would wish to call your attention, and that of your readers to, is the following:—The Chairman, in referring to a letter written by Mr. Varley in the *Mechanic's Magazine*, made a great show of, and laid great stress on one of his statements, that twelve or sixteen words per minute would be guaranteed to pass through the Atlantic cable, if the conductor weighed ninety-three lbs. per mile. So far so good. Mr. Varley has made that statement, and, of course, will abide by it; and if the shareholders of the Company are willing to accept it, so far good also. But the Chairman continued that Mr. Varley had requested, or somebody had proposed, that Mr. Varley should be sent out to Malta or Alexandria to experiment on and test the Government cable laid there for the purpose of seeing if his statement was correct. This was very good. If Dr. Cumming had such an opportunity of testing his prophecies, it would be interesting. Those who recollect Mr. Varley's expedition to the Banks of Newfoundland to assist Captain Kell to lift the old Atlantic cable, when some yards were recovered, will deprecate this second voyage. At all events let Mr. Varley pay all his expenses out of his own pocket, instead of drawing on the Company, who will find it quite enough trouble to raise the required capital without desiring to spend it unnecessarily.—I am, sir, your obedient servant, A. B.

To the Editor of THE ELECTRICIAN.

SIR,—I have pleasure in informing your correspondent W. N. B. that the contact-breaker of my induction coil is not worked by a separate electro-magnet. It simply consists of an iron hammer surmounting a brass spring placed vertically opposite one of the ends of the iron core. Near the bottom of this spring, I have an adjusting screw, so arranged that by screwing or unscrewing it, more or less pressure can be brought to bear on the spring for the purpose of adapting it to various battery powers. Immediately behind the hammer there is a pillar, in which is placed an adjusting screw, having a disc of platinum soldered to it. This forms one side of the break, while the back of the hammer, also tipped with platinum, forms the other side of it.

No. 35 is about 12s. 6d. per pound.—I am, sir, yours truly,
W. H. MONNEY.

To the Editor of THE ELECTRICIAN.

SIR,—Having seen an article in the ELECTRICIAN of the 12th inst., respecting the commercial capabilities of the London District Telegraph Company, will you kindly oblige by letting me know in your next on what principles it is worked, whether it is the needle or a printing telegraph; and, if the latter, on what material is the message recorded.—I remain, sir, yours obediently, W. BUSSELL.

Stonehouse, Devon. December 17th, 1862.

[The single needle and the printing instruments are both used; but the alphabet adopted in each case is that of Morse. With the printing instrument the ordinary rolls of paper, cut by Messrs. De la Rue, are employed. —ED. E.]

Telegraphic News.

ANOTHER FEAT IN TELEGRAPHY.

ON the occasion of the departure of Mr. Cyrus Field, in the *Persia*, for New York, the Submarine Telegraph Company despatched a message to their agent at Berlin, desiring him to make arrangements for the transmission of any item of news from the most distant available station in the Russian possessions, in time to meet the *Persia* at Queenstown. The understanding was that such news would, on the arrival of Mr. Field at New York, be telegraphed to California, so that, by this means, it would be ascertained in what period of time our present telegraphic system would allow of a message being transmitted from one to the other extremity of the habitable globe. The following despatch, transmitted from Omsk by the agent of Col. Romanoff, the constructor of the Siberian telegraphs, at 8 A.M. on the 21st. inst., was received at the central station of the Submarine Telegraph Company, at Threadneedle Street, at 9.59 A.M.

"*Omsk, 21st December*, 1862, 8 A.M.

"To-day, Sunday, a portion of the materials have arrived for the construction of the line to Lake Baikal."

This message, the transmission of which, it will be seen, occupied less than two hours, was immediately forwarded to Queenstown, and was duly received before the departure of the steamer.

PERSIAN GULF CABLE.

THE contract for sheathing the Persian Gulf Cable, 875 miles in length, the specification for which was lately published, has been given to Mr. W. T. Henley, of North Woolwich and Leadenhall Street.

Miscellanea.

THE PNEUMATIC DESPATCH.—The transmission of parcels and small goods from station to station through a confined iron tube by means of atmospheric exhaustion and pressure will soon be commenced. The London and North-Western Railway Company having granted a site for a station and receiving house, rent free, at Euston Square, a few yards from the Clearing House, the directors of the Pneumatic Despatch Company at once commenced operations by laying down beneath the roadway of Upper Seymour Street a line of iron tubing about half a mile in length, and extending from that terminus to the post office in Eversholt Street, under the superintendence of their engineer, Mr. T. W. Rammell. Within the iron tube, which is about two feet nine inches high, and two feet six inches wide (its section being similar to that of a railway tunnel in miniature) are two small ledges, or rails, on which the wheels of the small cars bearing the parcels will run. These will be propelled backwards and forwards, on the signal being given, by the exhaustion and pressure of the air in the tube. The immense disc and chamber in which it revolves have been removed from Battersea, and are being erected within the walls of the station and receiving house. The disc, or wheel, is twenty-one feet in diameter. It is composed of three sheets of wrought iron, the two which form the outside being each about an eight of an inch in thickness, while the centre and smaller plate is about a quarter of an inch thick. These are screwed on to sixteen spokes, which radiate from the centre of the wheel, and thus form thirty-two cavities, there being a distance between the plates of the rim of nearly two inches. Air chambers pass beneath the disc, which are exhausted by its revolutions in the race chamber. The wheel will be worked by a diagonal direct acting high-pressure engine of about 15-horse power. As regards the speed which will be attained, the railway company have only stipulated for a minimum of fifteen miles, but from experiments it has been shown that a speed of thirty-five miles can be attained. This, no doubt, will prove a most important acquisition to the post-office in the quick delivery of the mails. A number of workmen are now engaged in the construction of this line, which is expected to be finished in about a month's time. Arrangements have been made with Messrs. Pickford and Co., who have offered a site for the proposed station in Gresham Street, at a small rent. It is also proposed to form stations at Smithfield and Holborn Hill, which will be suitable for the large and small parcels traffic.

To Correspondents.

ST. LEONARD.—We insert an extract from Mr. Haworth's specification filed on the 26th September, 1862. We were not present at any of the experiments:—"The size and power of the battery will depend in some degree upon circumstances, such as the distance to which it is intended to convey the message, the strength and direction of the earth's currents, and even the state of the weather, more power being required in dry than in damp weather. These points must be taken into consideration and allowance made for them. For a distance of ten miles from Notting Hill, Bayswater, Middlesex, to Croydon, in Surrey, I have found a Smee's battery of two cells at each end, containing plates three by five inches, to suffice. For about fifty miles, from Notting Hill, Bayswater, to Brighton, in Sussex, I have used with success a Smee's battery of three cells at Notting Hill, and the same number at Brighton. For two hundred miles from Notting Hill, to Bangor, in Wales, I have required six cells with plates of the size above named. I have found that less power is generally required to convey a message from north to south and from south to north than from east to west, or from west to east."

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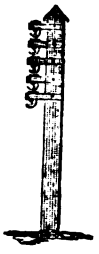

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The Electrician.

VOL. III. No. 61.—JANUARY 2, 1863.

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THE ATLANTIC TELEGRAPH.

WE have been somewhat amused, though certainly not gratified, by a trivial yet probably dangerous form of obstructiveness which, in several quarters, has been manifested in relation to the great project which now almost engrosses attention. As this enterprise approaches maturity, the opportunity it indirectly affords for putting forward effectively various plans and systems, more or less characterized by feasibility, appears to be more eagerly sought, and more unscrupulously employed, to the detriment of the main object towards which all endeavours should tend—viz., the extension and perfecting of our telegraphic system. The plan which is followed is simple, and tells wonderfully with the general public. Let the reader suppose himself to be the author or projector of a system for leading a telegraph wire, *viâ* the north pole or the tropics, to the American continent; for employing two dissimilar conductors, or none at all; or for floating instead of submerging the wire. Let him be so kind as to suppose also that the system, from various causes defined and undefined, has not met with the amount of notice and encouragement which might be considered due to it, and that discussion had been found rather to obliterate than to enhance its merits. Well, now that a definite and almost matured project, which, providing a few tolerably obvious requirements be adhered to, is supported by the conclusions so carefully worked out during the last few years by the Board of Trade and in other quarters, is fairly before the public; he has only to write to some influential and widely circulated organ of the public press, in order to secure the publicity and effect which he may have failed otherwise to obtain. Let him simply ignore the existence of the great ground work of facts upon which such an enterprise may now be based; and, while he hints with sufficient emphasis at the valuable means which *might* be adopted to remedy existing shortcomings, let him deprecate all active measures for an indefinite period, or until further experience and research shall have brought a certain system into conspicuous prominence. Writing thus, in the interests of the public, to warn against imminent if not inevitable loss, he cannot fail to meet with the preliminary attention necessary to secure the insertion of the letter. Then, if he cannot build a Temple of Diana at Ephesus, he may obtain notoriety by attempting to destroy it; and the reflection of such notoriety may very possibly promote the growth of his own particular scheme.

We hope that the recipe we have given may prove useful, though not in its more obvious application to the purpose of short-sighted self-interest and obstructiveness. Frankly, the proceeding we have indicated is worthy of all reprobation. Two continents, or two worlds, already united by civilization and by kindred origin, but separated by the expanse of the Atlantic, have for years been waiting for the means of intercommunication; while, in England especially, every effort, and the most careful study, have been directed to obtain adequate and secure data upon which our endeavours to this end might confidently be based. When the Committee, appointed by the Board of Trade and the Atlantic Telegraph Company, to inquire into the construction of submarine telegraph cables, issued their report, and stated their conviction that previous failure had been due to causes which might have been guarded against if adequate investigation had first been made into the question, and that, by applying the principles enumerated by the Committee, subsequent failure might be avoided, the question of an Atlantic Cable was already fully matured for practical realization. Confidence, however, when once shaken, returns but slowly; and it has been a work of time to obtain, on the part of the public, an appreciation of the important theoretical and practical progress which has been so carefully elaborated from the mass of evidence of various kinds laid before the Government Committee. There are now signs that public confidence *has* been restored; and the great work, which might safely have been undertaken eighteen months ago, appears to be on the eve of accomplishment. Is this to be postponed for an indefinite period, on the assumption that little or no experience has yet been gained in the question of deep-sea lines, or because, with the whispered suggestion of failure, schemes and systems yet in embryo, and liable to abortion, are put forward as likely to change the present features of telegraphy? Are the two hemispheres to be deprived of the invaluable benefits which would result from the means of telegraphic intercommunication, on the vague chance that in ten or twenty years the problem of laying an Atlantic cable might become more feasible than it is at the present moment? Those alone who are unacquainted with the present position of this problem, or who would seek to pervert and mis-apply the facts upon which our present experience is based, could adopt such a conclusion. Little can be gained by further procrastination that, even as far as particular interests are concerned, will bear comparison with the general loss resulting from the sacrifice of time. The next ten or twenty years will not furnish more *essential* data for the realization of telegraphic communication with America than those which, *tot funeris passis*, are found in the simple requirements of a large conductor, a light cable, and perfected insulation with low inductive capacity.

We are far from desiring to depreciate or to obstruct any suggestion which may tend to promote the ultimate success of this enterprise. It is unfair and unreasonable, however, to expect that the Atlantic Telegraph Company can take upon themselves the risk of practically verifying any or every suggestion which may be put forward on plausible grounds of theory or hypothesis. The wisest course is that which is most simply and obviously in accordance with data which have been amply verified and discussed, and that may be received upon almost unanimous authority. Were we to advocate the adoption, in this particular case, and without further verification, of the means we have lately pointed out for obviating inductive retardation, we should be in the position of several who, with a less disinterested motive than could actuate us in this matter, have put forward their claims to attention, to the detriment of the main object they profess to have in view; and, however plausible might be our grounds of argument, we should probably injure instead of serving the cause of telegraphic progress.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY, BY THE SUPPRESSION OF RETARDING INDUCTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 87.)

THE marine telegraph cable, from its locality when in use, and the particular construction which has been adopted to fit it for that locality, presents such great difficulties, unknown in aërial telegraphy, that it much needs amelioration by the application of new and better principles of electrical science. I am about to apply to it those consequent upon the definite electrical attraction

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set forth in the preceding papers, and I shall do it with full expectation of having their usefulness candidly inquired into, sooner or later, by the professional advisers of our public telegraph companies; I say *sooner or later*, for, as an amateur, my arguments may for a time be either ignored or unwelcome, as they at first were, when, upon an occasion which presented itself during my researches, I proposed to gas companies to improve their chemical practice of half a century. "Just let us alone, things are very well as they are," was said then, and may be repeated now, in thought, if not in deed. In that case, however, the speedy and almost universal adoption of my proposal proved that we are living too late in the history of the world for improvements that are palpable and possible to be silently neglected; so that if there be one to be offered in the present instance, the public may be left to themselves for demanding it. All the world is quite alive to the fact that the marine telegraph cable is not what it should be, and looks to the engineers, whom telegraphy has made electricians, to alter it; but the public will not forget that electricity has been a science longer than it has been an art, and that it is the business of the latter to improve itself by the former.

It has been shown that the induction of plus electricity on an aerial wire propagated into the surrounding atmosphere, stratum by stratum, causes a plus charge in each stratum of air by the virtual liberation of some of the electricity natural to that stratum; and that the attraction, which retains in position the electricity thus induced to become a plus charge, is antagonistic to the induction by which it is virtually set free. It will also have been perceived, that inasmuch as the induction of a given charge on the wire, and the antagonism in any number of concentric cylinders of air around it, become distributed over surfaces which increase as their respective distances from the common centre, so the intensity of the induction and antagonism must, according to the law of quantity, diminish in a rapid ratio, becoming at last insensible to our instruments; although the quantity of electricity virtually liberated in each of the consecutive cylinders of air continues precisely the same from the centre to a distance that is infinite. If we, therefore, fix upon any two concentric cylinders of air around the wire, they will be the seats of intensities that, in their totals, will be unequal; and the difference between these totals will denote the measure of motive tension by which plus electricity, if actually free to move as well as virtually free, would be passed from the inner to the outer of the two cylinders. It is on the same principles of action that, in the first instance, plus electricity will have passed into the wire, the only necessary condition having been that the antagonism was more intense in the old position than in the new one. The quantity of electricity that will be thus *acquirable* by the wire, denoting its changing capacity, is great just in inverse proportion to the antagonism immediately opposed in the *contiguous* cylinder of air to its induction. The same also is true, *virtually*, of the charging capacity of each aerial cylinder, its inability to receive charge by reason of its insulating nature being put out of the question. If we calculate the total amounts of antagonism in consecutive cylinders of air around a wire, we shall find they are to one another simply in inverse proportion to their distances from the common axis; and as the surfaces of the cylinders increase as the distances, so also do the numbers of aerial particles composing them; whence it follows, that if we condense into a cylinder of air, at any given distance, the quantity of air that exists at a double distance, we shall confer upon another cylinder, next within the former, a double charging (*virtual*) capacity; or, which is the same thing, if we practically make the atmosphere around a wire twice as dense, the charging capacity derived therefrom by the wire will be twice as great.

As it is with induction and its antagonism around a wire insulated by the air, so it must be with the same electrical actions when the wire is enveloped in any other insulating material—*the antagonism will be less as that material is more dense.* But, in addition to that, we know, from some early experiments by Cavendish, the more detailed researches of Faraday, and subsequent experience generally, that different insulating substances have different inductive capacities; the unequal influences of these unequal capacities upon the antagonism opposed to induction we shall presently have to take into account, when we have traced a little further the reduction of antagonism simply by distribution of the inductive action.

To proceed towards the particular conditions of the submarine cable, let us imagine we have a wire charged with a *given quantity* of plus electricity, and surrounded to an indefinite distance with *any* insulating material, which we must in all cases suppose to be in the form of concentric cylinders, each cylinder having the thickness of a single particle of the matter of which it is composed. By the electrical law of quantity the total amount of intensity in the whole of each of the cylinders* will be as its distance from the common axis inversely; and in each particle of any cylinder, inversely as the square of the distance. Now let all the cylinders be penetrated successively by a small portion of some other kind of common matter, made to take the place of its own volume of the matter previously existing there; the intruded body will of course sustain as much of the induction as is due to its assumed position, and which will be greater as the centre is more nearly approached, by reason of the greater proportion of which the size of the intruded body will bear to that of the cylinder into which it has entered. Fixing upon any distance for the actual position of the intruded body, and supposing it to be progressively increased in size, then the portion of the induction sustained by it will be greater as it becomes extended into a perfect cylinder, at which point it will assume the whole induction. We may next suppose the intruded cylinder to be a conducting one, and so uninsulated that the plus charge induced in it will escape into some position from which its inductive action can be opposed by no antagonism. The escape will not alter the intensity of induction and antagonism operating between the wire and the cylinder of insulating material immediately against it; and so long as their relation to one another remains the same, the propagation of induction, from one cylinder of insulating matter to the next contiguous to it, will go on as before. We cannot, therefore, *thus* get any increase in the charging capacity of the wire by uninsulating the distant surrounding cylinder of conducting matter; the uninsulation of which does, however, as we practically know, somehow or other, cause in the wire an increased capacity for charge, and how it does so it is very important for us to discover.

But we have not yet exhausted the inductive action which takes place from the charged wire. There is something more to be considered beside its propagation from one contiguous cylinder of particles to another. When we conceive static induction to act between two particles of common matter, however close they may be to one another, we necessarily involve the idea of the projection of the electrical attraction from one to the other through some minute distance; and the projection being once admitted, we have neither facts nor reasoning to suggest any probable limit to the distance through which it may take place, nor to deny that, like gravitation, electrical attraction may act through *all* distances. And as it can act independently of intervening matter, the accidental intervention of matter cannot be supposed to take from it that power. Therefore, if we have on a wire a plus electrical charge needing to act by induction on a distant surrounding cylinder of uninsulated conducting matter, and the intervening air be not adequate to support all its induction without virtually dismissing from its first and each succeeding cylinder more of its natural electricity than is retained by an intensity of attraction not greater than that of the charge (and which is impossible), the induction will only in part arrive at the uninsulated cylinder by propagation, the surplus being pro-

* "Steps to Theory, &c.," par. 70.

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jected across the sensible distance just as though it were not occupied by any matter whatever, the whole distribution of the induction resolving itself into a question of lesser amounts of antagonism.

Induction propagated from one insulating cylinder to another, and falling at last upon the uninsulated cylinder which we have been considering, can only liberate from the latter a quantity of electricity equal to that of the charge thus acting in the central wire; but still the mass of the uninsulated cylinder may have naturally within it many times that quantity of electricity held by no greater intensity of attraction; and if it have, all that remains of that larger portion would be susceptible of being liberated by a corresponding charge acting by induction projected upon the uninsulated cylinder, and its liberation would of course increase the charging capacity of the wire.

The charging capacities conferred by projection of induction, and that resulting from propagated induction, will change in their proportions to one another from two causes; for the former will vary with the distance of the uninsulated cylinder in conformity to the law of electrical attraction as regards distance, while the latter, acting always between contiguous particles, will be affected by distance only as it causes a greater or a lesser distribution, but it will vary also with the specific inductive capacities. For example: comparing together the charging capacities conferred, by *propagation* of induction to an insulated cylinder placed successively around a wire at two distances as 1 : 4, the capacities will be in the ratio of 2 : 1, respectively, because a double quantity has a quadrupled intensity at a given distance, which becomes reduced to unity by the distribution spread over a four-fold surface at a four-fold distance. Again: according to the law of COULOMB, and the electrical law of quantity, the charging capacities at various distances *projected* to the uninsulated cylinder will be simply as the distances inversely; the quantity of charge being given, let the distances be respectively as 1 : 2, then the larger cylinder at the greater distance will have twice as much electricity to liberate under a given intensity of induction as the smaller cylinder; but the induction upon it, by COULOMB's law, is only one-fourth as intense, and therefore we shall have $\frac{1}{4} \times 2 = \frac{1}{2}$, instead of $1 \times 1 = 1$ at the half distance. If we make the distance one-fourth, the quantity of electricity held with the same intensity in the much smaller cylinder will be only one-fourth as great; but the induction projected upon it will be 16 times more intense, and $\frac{1}{4}$th $\times$ 16 = 4.

It is easy to see, therefore, that the charging capacities consequent upon the uninsulation of a conducting cylinder placed around a wire at different distances would vary inversely in the simple inverse ratio of the distances, if there were only projection of the induction, and inversely as the square roots of the distances, if there were propagation of induction, and no projection; but as they both operate together, they may give rise in practice to a variety of intermediate ratios, according as the importance of the one or the other predominates.

The view of induction, as above given, enables us to understand how it is that solid insulators of the highest specific inductive capacities, placed in limited thickness around a wire suspended in the air, confer upon it no increase of charging capacity; for it is obvious, that although such a surrounding material may have within itself all that is needful, to enable it to receive from the wire, and to propagate onward through its substance the induction of a greater charge than the atmosphere can sustain, and transmit the induction of, still its acting efficiency must be limited by that of the air beyond having nothing else contiguous whose specific inductive capacity is superior to it.

If there be anything in nature that has a character that is not relative to some other thing, but absolutely inherent in it, it surely ought to be the physical force impressed upon matter for originating all its actions; and therefore we say, with a consciousness of reason, that however much the specific inductive capacities of bodies may differ, the laws (of electrical attraction) by which the inductions are governed must be the same for all of them. But experiments seem sometimes to be strangely at variance with that conclusion, until we become enabled to read them in a new light. A remarkable example of this, *à propos* to the present subject, may be found in the Appendix to the Report of the Submarine Telegraph Committee. At page 333 of that valuable compilation, Mr. LATIMER CLARK writes, after conducting a series of experiments, aided by Professor HUGHES, both gentlemen being careful manipulators: "We arrived at the singular conclusion that each di-electric substance has a different law of induction with relation to distance, forming another law of specific inductive capacity distinct from that of Faraday. According to this view, the amount of induction, through plates of different thicknesses, will in one material vary inversely as the square root of the thickness, but in another substance it will vary according to some totally different power." The two modes of induction which our physical view of electrical action makes unavoidable, and so circumstantially details with an exact correspondence with facts, remove the anomaly, and prove the case to have furnished only another instance of the mystery that may be introduced into the science by confounding together distinct elements of causation, of which we have already had one example in the mathematical blending of resistance and conductivity. And also, when an insulator around a wire is backed at any given distance by an uninsulated conducting cylinder, that the projected induction becomes greater as the specific inductive capacity is inferior, and also as the intensity of the charge on the wire is made greater.

(*To be concluded in our next.*)

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1830—MURPHY, P.—

[Rudiments of the Primary Forces of Gravity, Magnetism, and Electricity, in their Agency on the Heavenly Bodies. By P. Murphy, Esq. London: Printed for Whittaker, Treacher and Co., Ave Maria Lane, 1830.] —8vo.

1830—MURRAY, John.—

[A Treatise on Atmospherical Electricity, including Lightning Rods and Paragreles. By John Murray, F.G.S., &c., &c. London: Whittaker, Treacher and Co., Ave Maria Lane, and Daniel Lizars, Edinburgh, MDCCCXXX.]—Small 8vo., 150 pages, Illustrations.

1831—WEST, Francis.—

[The Electrician's Guide; being a brief outline of the amusing and instructive science of Electricity. Designed for the amusement and instruction of Young Persons. By Francis West, successor to Mr. Adams, Optical, Mathematical, and Philosophical Instrument Maker to His Majesty, 83. Fleet Street, London. Published by Chappel, Pall Mall, and Effingham Wilson, 88, Royal Exchange, 1831]—12mo., plates.—? number of pages, as Mr. Clark's copy is incomplete.

1832—POLLOCK, Thomas.—

[An attempt to explain the phenomena of Heat, Electricity, Galvanism, Magnetism, Gravitation and Light, on the assumption of one cause or universal principle. By Thomas Pollock. London: S. Highley, 32, Fleet Street, 1832.]—8vo., 158 pages. Cuts.

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1832—ROGET, P.M.—

[Library of Useful Knowledge. Treatise on Electricity, Galvanism, Magnetism, and Electro-Magnetism. By P. M. Roget, M.D., Secretary to the Royal Society, F.R.A.S., F.G.S., &c.; Fellow of the Royal College of Physicians, and Consulting Physician to the Queen Charlotte's Lying-in Hospital and to the Northern Dispensary. Published under the superintendence of the Society for the Diffusion of Useful Knowledge. London: Baldwin and Cradock, Paternoster Row, MDCCCXXXII.]—8vo., numerous woodcuts.

1833—MURPHY, Rev. R.—

[Elementary Principles of the Theories of Electricity, Heat, and Molecular Actions, designed for the use of Students in the University. By the Rev. R. Murphy, M.A., Fellow of Caius College.—Part I., on Electricity. Cambridge: Printed at the Pitt Press, by John Smith, printer to the University, for S. and J. J. Deighton, Trinity Street, Cambridge, and S. G. and F. Rivington, London. MDCCCXXXIII.]—8vo., 145 pages.

Entirely a mathematical work.

1833—MURRAY, John.—

[The Description of a New Lightning Conductor, and Observation on the Phenomena of Thunder Storms. By John Murray, F.S.A., F.L.S., F.G.S., &c. London: S. Heighley, Fleet Street, 1833.]

1833—METCALF, Samuel L.—

[New Theory of Terrestrial Magnetism (read before the New York Lyceum of Natural History). By Samuel L. Metcalf, M.D., Member of the New York Lyceum of Natural History. New York: C. and C. H. Carvill, MDCCCXXXIII.]—8vo., 154 pages.

1834—HIGGINS, W. Mullinger.—

[Alphabet of Electricity for the Use of Beginners. By W. Mullinger Higgins, F.G.S., &c. London: Orr and Smith, Amen Corner, Paternoster Row, MDCCCXXXIV.]—12mo., woodcuts.

1834—CUNNINGHAM, P.—

[On the Motions of the Earth and Heavenly Bodies, as explainable by Electro-Magnetic Attraction and Repulsion, and on the conception, growth and decay of Man, and cause and treatment of his Diseases, as referrable to galvanic action. By P. Cunningham, Surgeon, R.N. London: Cochrane and M'Crone, Waterloo Place, MDCCCXXXIV.]—8vo., 281 pages.

1836—POUILLET.—

[Elémens de Physique expérimentale et de Météorologie. Par M. Pouillet. Professeur de physique a la faculté des sciences et a l'Ecole Polytechnique; membre de la societé Philomatiqui, du conseil de la societé d'encouragement, etc. Bruxelles: Louis Hauman et Cie., 1836.]—Large 8vo., plates.

Livre Troisième, pages 163 to 196 Du Magnetism; Livre Quatrième, pages 197 to 241 De l'Electricité; Livre Cinquième, pages 242 to 278 De l'Electro-Magnetism.

1836—BRANDE, William Thomas.—

[A Manuel of Chemistry. By William Thomas Brande, of Her Majesty's Mint, F.R.S., &c. Fourth edition greatly enlarged. London: John W. Parker, West Strand, MDCCCXXXVI.]—large 8vo., 1320 pages, Illustrated. Chapter 4 on Electricity.

1837—BRAHAM, JOHN.—

[Outlines of the Science of Magnetism, Electro-Magnetism, Voltaic, Thermo, and Magneto-Electricity, showing in a concise manner their effects in a series of experiments, so arranged as to come within the sphere of general comprehension, illustrated with plates of the most approved apparatus, which will be found to explain the leading features of the sciences in order to produce a Motive Power. By John Braham, Optician, Mathematical and Philosophical Instrument Maker. Bristol: published by the Author, 8 Augustin's Parade; and sold by C. Tremlett, College Green; W. Strong, Clan Street, Bristol; and Fore Street, Exeter; and by C. Tilt, London, 1837.]—Pam., 12mo., 48 pages, plate.

1837—WEBSTER, Thomas.—

[The Elements of Physics. By Thomas Webster, M.A., of Trinity College, Cambridge, &c. London: printed for Scott, Webster, and Ceary, Charterhouse Square, 1837]—8vo., 490 pages, wooodcuts.

Contains, chap. xi., on Electricity, Galvanism and Magnetism; chap. xii., page 487, Theory of Electricity and Magnetism.

1837—STURGEON, William.—

[The Annals of Electricity, Magnetism, and Chemistry, and Guardian of Experimental Science. Conducted by William Sturgeon. Lecturer on Experimental Philosophy, at the honourable East India Company's Military Seminary, Addiscombe, &c. &c., and assisted by gentlemen eminent in their department of Philosophy. Vol. 1, October 1836 to October 1837. London: published by Sherwood, Gilbert, and Piper, Paternoster Row; and W. Annan, 12, Gracechurch Street; sold also by Messrs. Hodges and Smith, and Fannin and Co., Dublin; Maclachlan and Stewart, and Carfrae and Son, Edinburg; Mr. Robertson, Glasgow; Mr. Smith, Aberdeen; and Mr. Dobson, No. 108, Chestnut Street, Philadelphia, 1837.]—8vo., plates.

This is the first of the series, which consists of 8 volumes, the last being published in 1842. These volumes consist of the monthly numbers bound up, and contain numerous and valuable papers by Faraday, Soule, Dr. Lyon Playfair, Sturgeon, &c. &c. Proceedings of the "Electrical Society," &c.

1837—LEITHEAD, William.—

[Electricity. Its Nature, Operation, and Importance in the Phenomena of the Universe. By William Leithead, Secretary to the London Electrical Society. London: Longman, Orme, Brown, Green, and Longman's, Paternoster Row, 1837.]—10mo.

1838—BACHHOFFNER, G. D.—

[A popular treatise on Voltaic Electricity, and Electro-Magnetism; illustrated by numerous interesting experiments, with the mode of performing the same. By G. H. Bachhoffner. Author of "Chemistry, as applied to the Fine Arts." "The Medico-Chemical Compendium," &c. &c. London: published by Simpkin and Marshall, and E. Palmer, Chemical and Philosophical instrument maker, 103, Newgate Street, 1838.]—Pam., 8vo., 35 pages, plate.

OUR WILFUL HELPLESSNESS AGAINST FIRE.

APROPOS of the late fatal conflagration in Soho, the *Daily Telegraph* makes the following remarks:—"In the very heart of London six human beings have been burnt to death before succour could be brought. It is a fact which demands explanation. The locality is a poor one, and the house, like most of its fellows, was inhabited by a number of different families. It is supposed that the catastrophe was caused by an escape of gas. At any rate, it commenced in the lower

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part of the house, and, as the staircase was of wood, there was no possibility of the inmates escaping unhurt. A considerable time, according to the reports, elapsed before the engines arrived, and after their arrival there was an unaccountable delay in obtaining water. A correspondent, whose letter we publish, informs us that the firemen had the key to the water-tap, and were not allowed, by the orders issued to them, to use it till the turncock arrived. If so, there has never been a clearer case of life sacrificed to routine since the days of the Spanish king, who, according to the story, was burnt to death because his courtiers refused to pull off his blazing robes till the advent of the proper officer who was authorised by court etiquette to remove the Royal garments. As soon as the engines could be got to work the flames were promptly extinguished; but by that time it was too late to save the unhappy beings, who perished huddled together on the topmost floor. We have no wish, without further evidence, to assign any blame to the Brigade; but we feel that the occasion should not be lost for calling attention again to the defects in our whole mode of protection against fire. The calamity of Portland-street might be repeated to-night in any house in London; and the saying, which is as old as the days of Juvenal, of the "proximus ardet," should warn us that this is a danger which comes home to everyone of us, and in which our neighbour's peril is also our own. We have often suggested various improvements, which would promote the utility of our service. In the first place we must repeat again and again, that the number of stations and escapes is miserably inadequate. In many parts of London, and especially in the suburbs, you may walk for miles without coming across a depot of fire-engines, and when you do, you are sure to find it in some out-of-the-way court or alley. It is true that, sooner or later, the engines are sure to come up without being sent for; but then the slightest delay often makes the difference between ruin and safety, between life and the most awful of deaths. If a fire-escape, for instance, could have got to Portland-street before the house was absolutely enveloped in flames, the lives of the sufferers might have been saved. Another decided want is a system of signals. The one object ought to be to bring the engines on the ground as rapidly as possible. Almost every fire could be easily extinguished before the flames have got a-head; and every minute's delay adds to the difficulty in suppressing the conflagration. Now at present the men have to judge of the locality, either by street rumour or by the appearance of the sky. Anybody who has tried to discover the whereabouts of a London fire will understand how difficult it is for the members of the Brigade to ascertain the exact point at which their services are required. In New York this difficulty is obviated by a very simple method; the bell of the church nearest to the point is rung a certain number of times, to indicate in which ward the fire has commenced. All churches within hearing repeat the warning; and so on, till within a few minutes every soul knows both that there is a fire, and where it is."

The system we have for some time advocated, and which has now been happily initiated under the auspices of Captain Shaw, the present superintendent of the London Fire Brigade,—viz., the connection with each other, with the police stations, &c., of the various stations of the Brigade, promises to be a still more effectual safeguard against the extension of fires than are those which our contemporary has pointed out.

TELEGRAM *versus* FACT.

THE following letter, adverting to what appears to have been a most serious telegraphic misapprehension, has been addressed to the Editor of the *Daily News*:—

SIR,—On the 18th you published a letter of mine, calling attention to a most mischievous error in Mr. Reuter's epitome of President Lincoln's message, converting friendly reference to England into insult. I have not seen a correction from Mr. Reuter in any of the papers which published the misreport.

I now beg leave to ask what authority there is for the assertion made in Mr. Reuter's telegram, published last Saturday, that, in August last, Mr. Seward wrote, "a war with England could not fail to unite North and South." I have looked carefully through the published correspondence without finding this expression, or any warrant for the statement, in the telegram. I do not believe that Mr. Seward has written any such menace. There is a despatch in which he pleads for such a treatment of the questions between England and America as may preserve the peace between two countries, and says that the North would be united in self-defence; but it contains nothing like the menace which Mr. Reuter has put into his mouth.

This, sir, I beg to submit, is an important matter. It is little handy lies like these, which can be put into two lines, which every memory can retain, and which no correction overtakes, that breed war. The telegraph is a great convenience, but Heaven grant that the perverseness of man may not turn the blessings of science into a curse.—I am, &c.,

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January 2, 1862.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

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Stock	British and Irish Magnetic Tel.	100	58 to 63	——
20	Do. B 7 per cent. till 1862 .	—	——	——
Stock	Electric Telegraph . .	100	98 to 100xn	——
25	Do. New	—	——	——
5	London District Telegraph .	4¾	4 to 3 dis.	1¼ ⅜
10	Mediterranean Extension Tel.	all	3½ to 4	——
10	Do. 8 per cent. pref.	all	——	——
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	——
1	Do. registered . . .	all	⅜ to ⅝	——
10	Do. „ . . .	all	4 to 6	——
2	Telegraph to India . .	1	⅝ to ⅞ dis.	——
5	United Kingdom Telegraph .	8	¼ dis. to ¼ pm.	——

WASTE OF CITIES.

PARIS throws five millions a year into the sea. And this without metaphor. How, and in what manner? Day and night. With what thought? Without thinking of it. With what object? Without any object. For what return? For nothing. By means of what organ? By means of its intestine. What is its intestine? Its sewer. Five millions is the most moderate of the approximate figures which the estimates of special science give.

Science, after long experiment, now knows that the most fertilising, and the most effective of manures is that of man. The Chinese, we must say to our shame, knew it before us. No Chinese peasant, Eckeberg tells us, goes to the city without carrying back, at the two ends of his bamboo, two bucketsful of what we call filth. Thanks to human fertilisation, the earth in China is still as young as in the days of Abraham. Chinese wheat yields a hundred and twenty-fold. There is no guano comparable in fertility with the detritus of a capital. A great city is the most powerful of stercoraries. To employ the city to enrich the plain would be a sure success. If our gold is filth, on the other hand our filth is gold. What is done with this filth, gold? It is swept into the abyss.

We fit our convoys of ships, at great expense, to gather up at the South pole the droppings of petrels and penguins, and the incalculable element of wealth which we have under our own hand we send to the sea. All the human and animal manure which the world loses, if restored to the land instead of being thrown into the sea, would suffice to nourish the world.

These heaps of garbage at the corners of stone blocks, these tumbrils of mire jolting through the streets at night, these horrid scavengers' carts, these fetid streams of subterranean slime which the pavement hides from you, do you know what all this is? It is the flowering meadow, it is the green grass, it is majoram and thyme and sage, it is game, it is cattle, it is the satisfied low of huge oxen at evening, it is perfumed hay, it is golden corn, it is bread on your table, it is warm blood in your veins, it is health, it is joy, it is life! Thus wills that mysterious creation which is transformation and transfiguration in heaven. Put that into the great crucible; your abundance shall spring from it. The nutrition of the plains makes the nourishment of men. You have the power to throw away this wealth, and to think me ridiculous into the bargain. That will cap the climax of your ignorance.

Statistics show that France, alone, makes a liquidation of a hundred millions every year into the Atlantic from the mouths of her rivers. Mark this: with that hundred millions you might pay a quarter of the expenses of the Government. The cleverness of man is such that he prefers to throw this hundred millions into the gutter. It is the very substance of the people which is carried away here, drop by drop, there in floods, by

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the wretched vomiting of our s wers into the rivers, and the gigantic collection of our rivers into the ocean. Each hiccough of our cloaca costs us a thousand francs. From this come two results—the land is impoverished and the water infected; hunger rising from the furrow, and disease rising from the river. It is notorious, for instance, that at this hour the Thames is poisoning London.—*Victor Hugo.*

ON THE STUDY OF THE ELECTRIC SPARK BY THE AID OF PHOTOGRAPHY.*

BY PROF. OGDEN N. ROOD, OF TROY, N.Y.

PHOTOGRAPHIC images of the electric spark between the carbon electrodes of the voltaic pile were obtained on silver plates in November, 1840, by Prof. B. Silliman, jun., and Dr. W. H. Goode. These observers remarked the greater actinic activity of the negative spark as compared with the light from the positive electrode, which I believe is the earliest recorded observation on this point. These authors also noticed a double concentric structure in the impression from the electric spark, similar to that described in this paper.

Photographs of the stratification and luminous discharges in Geisler's tubes, were obtained in the spring of 1860, by Professor W. B. Rogers, of Boston, operating with one of Ritchie's coils. These results were communicated to the British Association at their Oxford meeting in June, 1860.

Similar photographs were obtained by Gunther and Dove, and presented by the latter to the Prussian Academy, on the 27th of May, 1861. A photographic camera was employed, and an exposure of from 3½ to 6 minutes. In the same number of *Poggendorff's Journal*, W. Feddersen, in a highly interesting article on the electric discharge from the Leyden jar, states that, by means of a concave mirror, silvered according to Leibig's process, he obtained fine photographs of the electric spark, even when the mirror was in rapid rotation. Photographs of the spectra from the spark of Ruhmkorff's coil have also been obtained by Prof. W. A. Miller.

In all these cases the electric line was photographed from a position at right angles to its motion, a side view being obtained. My object in the present article is to describe a very simple and easy method of obtaining remarkably fine photographs of the electric spark from a point of view parallel to the direction of its motion, the pictures being as it were transverse sections of the spark and of the electric brush in all its variety. The very short duration of the electrical discharge renders its study by ordinary means difficult and uncertain; while photography, by revealing a mass of new details otherwise invisible, and furnishing a permanent record, which can be studied at leisure, offers advantages that cannot be too highly estimated.

Method Employed.—M. E. Becquerel showed, several years ago, that paper coated with the bromide of silver is sensitive to the light of the electric spark; the discharge of a battery of four Leyden jars in its immediate neighbourhood causing a slight darkening. When a single spark was allowed to strike the paper, no effect was produced.

In experiments on instantaneous photography with the wet collodion process, I was often encountered by the well-known fact that, while those portions of the sensitive surface which had been acted on by a very bright light darkened strongly under the developing solution, adjacent parts, where the action of the light had been somewhat feebler, remained quite transparent and free from a deposit of silver. This rendered it probable to me that if the electric spark were made to strike directly on the sensitive surface, only those portions would be effected which were in immediate contact with the luminous atmosphere. Actual experiment confirmed this idea to a most surprising degree. When a single spark was allowed to fall on the sensitive surface, under the action of the developing solution, a fine intense, and sharply-defined image, full of delicate details, was produced. The sharpness and perfection of these images was such that they bore examination by the microscope under a power of 40 diameters, while there was not the least difficulty in enlarging them by means of photography as high as 20 diameters. The enlarged negatives then furnished good prints on paper. Sometimes the small original images were accompanied by an irregular partial halo caused by the diffused light of the spark, but this for the most part was so faint as in no way to interfere with the distinctness of their outline.

The question naturally arises whether these delicate and beautiful images are produced by the action of the *light* on the sensitive plate, or are owing to a decomposition of the silver salt by electrical agency: in other words, whether these pictures are photographs or electrographs. That they are due to the action of light the following experiments will render probable.

(1.) Sparks were allowed to fall on sensitive plates, and their form was observed by the aid of a lens of one inch focal length: on developing the latent images, they corresponded in shape with those observed.

(2.) A glass plate was coated with plain collodion, free from iodide or bromide, and allowed to remain five minutes in the bath of nitrate of silver. It was then removed, and single sparks were allowed to fall on different portions of the wet collodion surface. Under the action of the developer, the well-known spark images appeared.

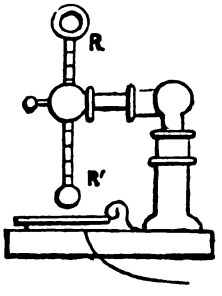
A simple clean glass plate without any coating at all was placed in the nitrate bath for a few seconds. On its removal, and while still quite wet, sparks were discharged on different portions of its surface. When the sulphate of iron developing solution was poured over it as usual, clear sharp images of the spark were obtained!

As plain collodion, free from iodide and bromide, as well as simple glass-plates moistened merely by the nitrate bath, have not been considered by photographers as sensitive to light, these unexpected results rendered it probable that the electrical discharge produced a decomposition of the nitrate of silver. I was, however, enabled to prove that these surfaces really are sensitive to *light*, in the following manner:—A plate coated with collodion, free from iodide or bromide, but saturated with a solution of nitrate of silver from the bath, was placed in a camera, which was directed towards a window with a bright sky beyond. The lens used was the "portrait combination," its focal length being six inches, with an aperture of 1½ inches: the exposure lasted ten minutes, the full aperture being used. Under the sulphate of iron solution, a distinct image of the window, of no great intensity, was obtained. Next, sunlight was concentrated by a "bull's-eye" condenser on a little stand, which, to avoid too great heat, was arranged so that its surface was about half-way between the lens and its focus, the bright spot on the stand covering an oval space ¾ of an inch in diameter, and two inches long. A plate merely moistened by immersion in the nitrate bath was placed on the stand for ten seconds, and then developed by the sulphate of iron solution, which brought out an intense image of the oval spot.

(3.) The image of the positive spark falling on a plate merely wet with nitrate of silver has a peculiar and definite form. If this form is really traced by *light*, we should expect that the light would be able to act on another sensitive plate placed directly under and in contact with the first. This was found to be the case. A glass plate coated with sensitive collodion, on its removal from the nitrate bath, was covered with a piece of the very thin glass used for microscopic purposes, the latter having previously been moistened by a solution of the nitrate of silver; sparks were then discharged on the covering plate of thin glass. When the latter was removed, and the collodion surface developed as usual, images of the spark were obtained. The definition was much impaired, and the intensity lessened. When the thin glass was blackened so as not to transmit light, and the experiment repeated, no images were produced, not even by allowing a large number of sparks to strike the same spot.

Apparatus for the Production of the Photographs.—For the generation of the electricity a small cylinder machine was used. The diameter of the cylinder was seven inches, its length ten inches; the prime conductor exposed a surface of 200 square inches.

Fig. 1.



The apparatus for throwing the spark on the sensitive plate is seen in the diagram. A brass rod, R R', terminated by a freshly polished brass ball, six-tenths of an inch in diameter, is supported over the centre of the sensitive plate, and insulated in the manner seen in the woodcut (*fig.* 1). The rod is graduated and held in position by a binding screw. The sensitive plate is supported on a silver disc, which is in metallic connexion with the rubber of the machine. A

* From the *American Journal of Science and Art.*

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weak spring of platinum foil rests on the collodion film, and connects it with the silver disc. R is connected with the prime conductor.

The manipulation was as follows:—A glass plate three inches square was carefully cleaned, coated with collodion, and sensitised in a bath of nitrate of silver of 40 grains to the ounce of water. The plate, on being taken from the bath, was held in an upright position, so that it could *drain* for one or two minutes: it was then placed on the stand, and the machine very slowly turned, until an apparently single discharge had been effected, when the plate was removed about three-tenths of an inch, and the operation repeated until twenty sparks had fallen upon it. The plate was then developed and fixed as usual. After each experiment the brass ball was wiped to remove dust, &c.

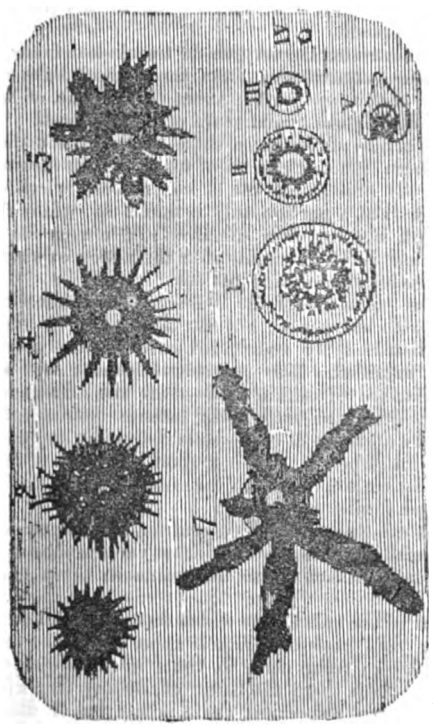
The pictures produced in this way are apt to be too intense, whereby the interior details are often unobscured. Some care must, therefore, be taken in the selection of a collodion; that which is suitable for "ambrotypes" is to be preferred. The following formula answered well in my hands:—

Plain collodion	8 ounces
Iodide of potassium	40 grains
Bromide of ammonium...	20 „

This collodion should be used while still new, as it then is sensitive and not too intense in its action.

The positive electrical spark, under these circumstances, consists of a combination of two figures, viz., a star and one or more rings. The relation which they hold to each other is modified by the distance the spark travels in the air; that is, by the tension of the electricity. The two figures are usually arranged with a considerable degree of symmetry. The very marked difference in these two components, and the fact that the annular form is, as I shall show, characteristic of the electrical brush, seems to indicate that each simple spark consists of two or more successive discharges of different intensity. The woodcuts showing the forms of the spark were executed from photographs enlarged nine diameters; in them the bright portions of the spark are of course represented by dark shading, &c.

Fig. 2.



Distance of the brass ball from the sensitive plate $\frac{1}{16}$-inch. The most general form is that seen at diagram 2, at .1. The starlike figure is very distinct. One of the rings is included within its area, and faintly indicated by a deeper shade; the other ring is sometimes seen circumscribing it.

$\frac{2}{16}$. 2. The rays are larger, and the external ring is plainly visible.

$\frac{3}{16}$ and $\frac{4}{16}$. 4. The rays increase in size, and the ring is well developed.

$\frac{5}{16}$. Like the above, except that the rays begin to grow irregular.

$\frac{6}{16}$. Rays quite irregular; both rings distinctly visible.

$\frac{7}{16}$, $\frac{8}{16}$, $\frac{9}{16}$, $1\frac{1}{16}$, $1\frac{2}{16}$. The star loses its regularity, and the rings are no longer symmetrically disposed.

$1\frac{3}{16}$. No spark passes over: it is replaced by the electrical brush, or rather by discharges intermediate between the brush and the true spark, *fig.* 2, I.

These produce a strong impression on the plate, and yield intense sharp figures, consisting of three parts:—An external sharply defined circle, within a series of dots arranged in a circle; and finally, innermost of all, a broad ring which may pass by delicate gradations into a star. This would indicate that the partial spark consists, under these circumstances, of at least three successive discharges of electricity of different tension. The circles on the plate seem to have exactly the same diameter they possess in the air. This is strongly suggested by the following experiment:—If the plate is held obliquely, the partial sparks generally pass near its surfaces for some little distance before actually coming in contact with it, and their path is

Fig. 3.

marked by comet-like tails (see *fig.* 3). The diameter of these tails is the same with that of the circles. This is also true of the brush.

Electrical Brush.—When owing to distance or the use of a pointed wire these partial sparks become reduced in intensity, we have the electrical brush: its form is slightly removed from the last. The middle circle of dots vanishes, as well as the projections from the broad inner ring; and we have two concentric rings, the smaller one being most strongly marked. If the brush be still further reduced in intensity, the external circle becomes very faint, and finally disappears, and but a single circle is left.—*fig.* 2. III., IV.

Electricians have long since arrived at the conclusion that the electrical spark passes by insensible gradations into the electrical brush, and I find that photography furnishes a beautiful confirmation of this view. Thus the figures I, II, III, IV, *fig.* 2, are selected from photographs forming the first members of a series which would illustrate the gradual conversion of one of these forms into the other, and the other members could easily be added.

We have seen that while the electrical brush is characterised by the annular form, electricity of higher tension generates star-like figures, the rays being larger in proportion to the tension up to a certain point. Now the constant occurrence of a combination of these two forms, in the photographs of *bright sparks*, points out, I think, clearly, that these sparks consist also of more than one discharge; moreover, the ring, where it cuts the rays of the star, can often be traced under them, as though superposition had taken place. Again, when the bright spark travels some distance, the ring is generally not symmetrically placed, as though the discharge producing it had followed a slightly different path. Indications are constantly observed which lead to the idea that even the star itself is produced by the overlapping of two stars, having rays of different size and different intensity.

The wet collodion film offers, of course, a certain amount of resistance to the passage of electricity over its surface, and thus furnishes us with the different indications above described.

Finally, as the researches of Reiss, Kirchhoft, Helmholtz, and Feddersen, have shown that the electrical discharge is oscillatory and wave-like, I am the more inclined to regard these photographic figures as produced by a series of consecutive discharges of different intensity.

Before passing on to the next point of interest, I will allude to a curious modification which the positive partial spark undergoes if the machine be turned rapidly, so that a large number of them fall quickly on the same spot: see V. *fig.* 2. Many of the partial sparks are arranged rapidly around the point under the brass ball, the pointed portion being turned outward.—*American Journal of Science and Art.*

AUSTRALIAN RESINS, GUMS, AND GUM-RESINS

Of the resins proper, two representatives only, the products of indigenous trees, are at present known to exist in Victoria, namely, that from the Callitris verrucosa and cupressiformis, and from the Xanthorrhœa

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Australis. The first-mentioned resin, from the two trees commonly known as the Desert and Mountain Cypress Pine, may be collected in the northern and north-western barts of the Colony in considerable abundance. It exudes naturally from the bark in tears, or small pendulous masses, and also flows from incisions made to encourage exudation. This substance may be described as a resin of excellent quality, almost identical with the best samples of Sandarac from the Callitris quadrivalvis of the Mediterranean, so largely used in the manufacture of varnishes. It is a transparent, colourless, or pale yellow body, fragrant and friable, fusing at a moderate heat, and burning with a large smoky flame, very soluble in alcohol and the essential oils, and almost totally so in ether; turpentine at ordinary temperatures does not act upon it, nor do the drying oils, but it may be made to combine with those solvents by previous fusion.

The balsamic resin from the Xanthorrhœa Australis is a substance of much interest. It is found in masses of irregular globular shape, within the body of the tree, and exuding in large tears and drops near its roots. It is a dark red friable substance, the purer homogenous specimens exhibiting a most brilliant ruby colour when crushed into fragments; it fuses readily with the same deep colour, and exhales the characteristic odour of gum benzoin and dragon's blood under such circumstances. In many respects it resembles the last named substance, but its solutions are intensely red, inclining to yellow, while as a varnish it has much more body and gloss. When grass-tree gum is ignited it burns with considerable energy, and its destructive distillation gives rise to liquid as well as solid products, which have not as yet been investigated. It is very soluble in alcohol, and in the essential oils from the Eucalypti, that from the Dandenong Peppermint proving an exception, as already mentioned. Ether takes up a portion only, leaving behind a resinous substance coloured more intensely red than that which it dissolves; turpentine exercises no solvent action upon it, and the drying oils but very little. According to Mr. John Kruse, of Melbourne, who examined this substance, and published the results he obtained in the Journal of the Pharmaceutical Society of Victoria, July, 1858, grass-tree gum contains cinnamic in addition to benzoic acid; and he also mentions the interesting fact, that the action of nitric acid upon it gives rise to picric acid, which he states to be of practical use for dying yellows upon silk or wool.

The Xanthorrhœa Australis is very common in many parts of Victoria, in some healthy localities, as in Gipps Land, covering tracts of many square miles in extent; and the resin—were its uses properly investigated and determined, and thereby drawn into technical use—might be collected in very large quantities.

A very intetesting discovery of fossil resin has been made by Mr. Richard Daintree of the Victorian Geological Survey, in the tertiary lignites of the Bass River, in the Western Port district. This remarkable substance was obtained at a depth of about 50 feet below the surface; the formation in which it occurs is of great extent, but not sufficiently explored at present to enable an estimate to be made of the probable quantity of resin available. Like many fossil substances of this class, the resin from the Bass River is not easily dissolved in the ordinary menstrua; alcohol and ether take up a portion of it, the former giving rise to a brown coloured solution, leaving the insoluble remainder in a swelled and bleached state; the latter forms a clear colourless solution, which by evaporation leaves a pure white residual resin. Turpentine does not exert any solvent power, while the essential oils from Victorian Myrtaceous trees appear to be its best solvents, as only a small insoluble portion remains after their action, consisting to a great extent of mineral impurities. This resinous body appears in small rounded masses, somewhat translucent internally, but possessed of a rough opaque covering; its colour is a pale brownish-grey, with a glassy fracture; it is very friable, and inflammable. On peing heated it fuses with the disengagement of much volatile matter, causing a frothiness that does not subside for some time. It is less fragrant under these circumstances than the fossil resin of New Zealand, the odour resembling that of Sandarac, a circumstance leading to the opinion that this substance was originally the produce of a tree allied to the genus Callitris. It burns readily, leaving unconsumed a quantity of bright and bulky charcoal.

The genus Acacia furnishes several true gums, of which those from the species A. molissima, A. dealbata, A. pycnantha, and A. homalophylla, are the most important. These substances exude from the trees, as do the Acacia-gums of commerce, and occur in rounded or irregularly-formed masses, at times almost colourless or pale yellow, but not unfrequently tinged with red or brown. Some samples are occasionally so intersected with an infinite number of cracks as to present an amorphous white appearance. Generally speaking, the Victorian Acacia-gums are somewhat less soluble than the gum arabic of commerce; but, on the other hand, they appear to yield a more adhesive mucilage, which is less liable to splinter and crack when dry. Most of these bodies possess a slight amount of astringency, which varies in one and the same sample from a single tree; and it would seem that while this peculiarity is absent, or but very faintly perceptible, in the pale-coloured pieces, it increases in proportion as the colour of the gum deepens—a circumstance which would much facilitate their classification.

Under the term gum-resins, a numerous series of indigenous vegetable productions may be classed, which could be procured in great abundance in Victoria, but which have not hitherto received the attention they deserve. They are produced in greater or lesser quantities by all the species of the genus Eucalyptus, and might be largely accumulated with little trouble by wood-splitters and sawyers throughout the forest of the country.

These substances occur within the trunks of trees of all sizes, in flattened cavities in the otherwise solid wood, which often lie parallel to the rings of growth. In such places the deposition of gum, which is at first a viscid liquid, becomes gradually inspissated, and subsequently hard and brittle. The liquid gum may also be obtained by suitable incisions in the stems of growing trees; but whether such a method affords greater facilities for its collection than those naturally offered, appears to be still and undecided question.

In their general charateristics the gum-resins from the Eucalypti resemble each other very closely. When in the solid form, they present the appearance of small angular masses, intermixed with occasional striated pieces and particles of wood. The prevailing colour is dark red-brown, in some cases dull with olive and yellowish tints, in others bright ruby-coloured and transparent; black and opaque pieces are also very commonly found interspersed through each of the several descriptions of gum-resin.

The fracture, when these substances are thoroughly dried in the water-bath, is vitreous, and they are moreover then exceedingly friable, and easily pulverized. Desiccation in this way causes them to lose from 15 to 20 per cent. of their weight.

In the mouth they are tough and adhere to the teeth, colouring the saliva red; their taste is intensely astringent, without much bitterness; although it should be remarked that in this particular they are not all equally potent.

The liquid gum-resins are very viscid treacle-like fluids, which do not differ in chemical constitution from those which have undergone induration, save that they contain about 65 per cent. of water, capable of being expelled by the temperature of a water-bath.

The solvent action of water on these bodies is not the same in the case of gums from different species of trees. If for instance cold water be poured on the produce of the E. corymbosa, whether it be in the solid or liquid state, a portion only is taken up, while the gum from the stringy bark is completely dissolved. When, as in the case just cited, a flocculent residue remains after the action of water, a few drops of ammonia render the solution perfect.

The aqueous solutions of the Eucalyptine gum-resins all give an acid reaction with test-paper; but the differences in the behaviour of each, when dissolved by water, subjected to the several re-agents, become very manifest. The precipitate caused by a solution of gelatine—indicative of tannic acid—does not appear in any case to correspond in quantity with their intense astringent taste; and occasionally the addition of that substance causes no precipitate at all. This fact has an important bearing upon the value of this whole class of bodies under consideration for tanning purposes, and as substitutes for catechu and similar bodies.

With acetate of lead these astringent bodies give copious gelatinous precipitates; and with the salts of iron various shades of green and black. The mineral acids also determine in them bulky flocculent deposits.

One or more of the substances which have been made the subjcet of the foregoing very imperfect sketch appear to have been forwarded from these colonies from time to time, in small quantities, to Great Britain, and to bear there the name of Botany Bay kino; but little seems to be known respecting their properties or uses, the general belief being that Australion kino is only furnished by the Ironbark tree (E. resinifera). It becomes, therefore, the more necessary to follow up this subject to a conclusive termination, to establish by a searching chemical investigation the proper uses of substances so abundantly available, and thereby increase the industry and prosperity of the land.—*Prefatory Essays, indicating the Progress, &c., of the Colony of Victoria.*

AUSTRALIAN TELEGRAPHS.

ONE thousand five hundred and four miles of ELECTRIC TELEGRAPH

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have been established within our boundaries, at a cost of £163,000. The connection with the capitals of the adjoining Governments—Adelaide, 800 miles on the north-west; Hobart Town, 300 miles to the south (a portion submarine, unhappily interrupted at present); Sydney, 600 miles on the north-east—has been completed for some time, and that with Brisbane, the capital of Queensland, will be perfected ere long, which will give in extreme length a line for transmission by the wire of considerably above 2,000 miles. It may be the good fortune of the person honoured with the discharge of the duties of President at the next Exhibition to announce that we are brought into actual contact with the great metropolis of the empire. The use of this wonderful agent has been placed at the disposal ot the Commissione's by Her Majesty's Government, an act which has much facilitated communication with the remote interior.

It may incidentally be remarked, for the benefit of those whom it may concern, that the working apparatus in the north-west corner of the building, near the branch of the Post Office, is *en rapport* with the detective and chief Police Stations, and that a code of signals has been prepared, by which, if necessary, intelligence may be flashed in any direction, and to any distance.—*Prefatory Essays, indicating the Progress &c. of the Colony of Victoria.*

THE ACCIDENT TO THE GREAT EASTERN.

WE quote from the *Times* the following observations relative to this subject, and to the necessity for the Atlantic telegraph:—

"The accident to the *Great Eastern* adds another proof of the paramount importance of an Atlantic telegraph to the commercial interests both of this country and America. Had such a means of communication existed, the ship company might possibly have been saved some thousands of pounds. The *Great Eastern* in her damaged condition, was fully as safe as any ship constructed upon the ordinary plan, and the company might very likely have determined upon ordering her home, if the agents had been able to communicate by telegraph, and to have received the reply of the directors in twenty-four hours, instead of, at least, four weeks, which the course of post occupies. In the present state of things the agents were obliged to use their own discretion, and, in the exercise of that, decided on doing the work in New York in preference to sending the ship home without attempting her repair."

ATLANTIC TELEGRAPH COMPANY.

WE quote the two letters given below, with their respective headings from the money articles of *The Times* of the 22nd and 24th instant:—

"The following relates to the proposal of the Atlantic Telegraph Company for a fresh attempt to connect Europe and America. Although there is no undertaking which the public more ardently desire to see accomplished, it is necessary to allow every risk to be pointed out, in order that no person should enter into it without being prepared for all contingencies. As the Government guarantee is merely to be in force while the line is in successful operation, this feature is practically valueless, since if the line be really laid and worked it will require no Government aid whatever:—

"SIR,—The directors of the Atlantic Telegraph Company appear, from their new prospectus, referred to in your city article to-day, to be well satisfied that it has become 'comparatively easy to accomplish' the laying of their proposed telegraph cable in a depth of 2,000 fathoms, and in a single span 2,000 miles in length. I should be the first to encourage and assist any well matured plan for another attempt to unite Europe with America by whichever of the various routes may be determined, after close and impartial investigation, to be the best; the great risk of laying and maintaining a cable in a great depth of water has, however, to be dealt with in different degrees, whether the line be attempted by the long, direct route, or by sectional lengths either by the North or South Atlantic routes. The directors of the Atlantic Company still estimate this, their great difficulty, very lightly, notwithstanding their former experience of the weather to be encountered in attempting to carry out so long an arduous an operation as the submergence of a cable between Ireland and Newfoundland, and the impossibility of effecting any repairs should a defect again occur in deep water after it has been laid. It is no doubt 'comparatively easy' to lay and to maintain telegraph tables in water sufficiently shallow to admit of faults being repaired, although cables even of this class have not yet been worked with success in single circuits of more than 700 miles. But with deep-sea lines there has not been a single instance of success since the former Atlantic line was attempted. The Malta and Cagliari, Malta and Corfu, Candia and Alexandria, Red Sea, and all other similar undertakings, have proved signal failures. The line between France and Algiers, completed last year, which passes over about 1,500 fathoms, and is 500 miles in length, or about a quarter of the proposed Atlantic line, was mentioned by the chairman at the recent meeting of the company as an instance of a successful deep-sea line. If the line had really been in working order, its duration of life has hardly been sufficient to be cited as an example of permanence, but it is unfortunately the case that the line ceased to work some weeks prior to the meeting. The history of this ill-starred line is, indeed, a warning which should not be forgotten.

"It happens that, in the centre of the route adopted, the cable had to pass over some miles of shoal water, on each side of which the water was very deep. In the first attempt to lay the line the steamer started from Algiers, and, after paying out the greater part of the cable, met with a heavy gale of wind, which resulted in the cable breaking about 50 miles from the coast of France. The fortunate occurrence of shallow water midway in the track admitted of the recovery of the cable there, so that it was possible to join on a new line then to the half of the cable laid from Algiers, the other part towards France being abandoned. A new cable was accordingly made, but during the attempt to lay it the steamer engaged in the work was run into by a French steam frigate, and for the second time the enterprise had to be abandoned. A third attempt resulted in success for the time, but, after working for a short period, the line has broken down. This cannot be considered as a sufficiently great success to warrant the risk of £600,000 on a line four times the length, even if a convenient series of shoal-water patches about 200 miles apart could be discovered between Ireland and Newfoundland. Any rash attempt to lay a line across the Atlantic until we have better experience of the permanence of shorter deep-sea lines will postpone the ultimate connexion of the two continents for many years, and will most seriously injure the progress of electric telegraphy. "Yours obediently, MERCATOR."

"Subjoined is a communication from the Atlantic Telegraph Company. It refers, in what seems to be an unjustifiably harsh tone, to a letter signed "Mercator," inserted the day before yesterday, and which was temperately written, and contained nothing that could be regarded as an attempt, either direct or indirect, to cast a personal imputation of any kind:—

"22, *Old Broad Street, London, Dec.* 23.

"SIR,—By publishing a letter signed 'Mercator' in your Money Article of yesterday you have given to it an importance which neither the real name of the writer or its substance could command.

"I will not occupy your space in exposing the inaccuracy of 'Mercator's' figures, all of which are wide of the truth, or in rectifying his facts, some of which are erroneous. Still less would it be becoming in me to undertake the defence of our chairman against the unworthy insinuation of dishonestly concealing the fact of the temporary interruption of the Toulon and Algiers line of telegraph when he referred to it at the late meeting of our shareholders. The honour of our chairman is safe in his own hands, and I believe it would be offensive to him to say more on this point.

"But it may be important to point out that, though it be the fact, as we are now informed, that the Algerian cable has, after two years, been temporarily interrupted in the midst of its successful working by an accident probably resulting from one of those terrific hurricanes which have lately visited Marseilles and the whole Gulf of Lyons, yet its history is encouraging as an instance of what would now be considered a very imperfect cable, laid more than two years ago, over a volcanic and rocky bottom, without any survey, and without much of the experience and scientific organization now at the command of electricians and contractors; but, in spite of these disadvantages, working efficiently and profitably at a rate of 18 words a minute for two years, instead of 'a short period.' In this sense, down to the time of the present accidental interruption, it might well be quoted by our chairman as one of the many proofs of the facility with which telegraph cables can be laid and worked in depths approaching to those of the Atlantic, with the present improved means and increased experience; and it may be remarked, in passing, that even two years' revenue only from an Atlantic cable would be in all probability more than sufficient to recoup the whole capital of the shareholders.

"The greatest depth of the Algerian line is no less than 1,585 fathoms (not 1,500, as stated by 'Mercator'), its length 550 miles, not 500 (as again stated); and 'Mercator,' if his object were truth, might have mentioned that, according to the only information published, the injury it has received has occurred, not in *deep* water, but in the comparatively shallow depths in the offing of the French coast.

"The Algerian cable was starved in its vital points, as was noticed even at the time of its manufacture, three years ago; but it was laid, as even 'Mercator' shows, in spite of terrible and exceptional weather. It has been injured in a hurricane—not irrevocably, as I have good reason to believe, on the authority of a French scientific journal—and when that portion of it which has been found too fragile for shallow water shall have been replaced by the massive sheath which experience has shown to be necessary in such cases, it is to be hoped that no more difficulty will occur.

"As to the other failures cited by 'Mercator' it is well known to every telegraphist that they never were deserving of success, and as was admirably shown by the late President of the Institution of Civil Engineers, in summing up a somewhat recent discussion on the subject of that institution, their want of success was a case for the consideration of the moralist far more than the man of science.

"Your correspondent is right in suggesting the 'weather to be encountered' as the most serious risk in laying cables, whether in shallow or deep water; but this danger, instead of being diminished, would have others superadded to it, by going, as he suggests, to the North or South

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Atlantic to meet the icebergs and icebound coasts of the one, or the volcanic bottom and tropical heats of the other. His suggestion, however, betrays the source from whence his letter comes, which is well known to our directors, even through the mask of an assumed signature, which is indeed wisely chosen, as the real one would probably be the best antidote to the writer's attempt to obstruct a great national undertaking.

"Yours truly, GEO. SAWARD, *Secretary*.

THE TELEGRAPH TO INDIA.

(*From the Times.*)

THE laws which govern the promotion of telegraphic enterprise are apparently as mysterious as those which, in spite of all scientific prophecies to the contrary, so hamper and retard the profitable working of all long deep-sea routes. Like gigantic boa constrictors, these huge sea cables have their regular periods of torpor and keen voracity, the latter never to be appeased with anything short of the uttermost farthing subscribed by the luckless shareholders. If latterly the pythons have had rather a long repose, it must be recollected that two unusually full meals preceded it, and that it was not till all the subscribers to the old Atlantic and the Red Sea telegraphs had been squeezed totally dry, that the monsters relaxed their hold, and wriggled out of the money-market when there was no more to be had. Since then the animals have been rather difficult to feed, and the commercial world has had a not unreasonable dislike to these submarine boas, which require such enormous sums to gorge them, and which become torpid immediately after the last £50,000 has been thrown into the sea with them. The terror which their feats of this kind have inspired in the Atlantic, the Mediterranean, the Red Sea,—in short, wherever there was water deep enough to make the money sunk in them a hopeless loss,—has been so great that it is almost certain they never would have had another meal of English shareholders if the Government had not stepped in and shown, in the case of the Malta and Alexandria cable, that, when kept within reasonable limits as to length, these deep-sea animals might be fed and made useful without danger of their devouring the substance of all who came within their reach. The example thus set by the Government has, to a certain extent, restored public confidence; the more so as their success was known to be due entirely to the observance of such simple rules as are necessary to success in all commercial undertakings. They took care in the first place to pay the price required for a really good cable, and to see that they got what they paid for; and having got it, they insured its working by not submerging it in one unbroken deep-sea length, but divided it into short sections, so as to enable it not only to work well, but profitably in point of speed. This it has done with such regularity and completeness ever since it was laid, that confidence in the feasibility and profitableness of submarine lines in short lengths has been, as we have said, to a certain extent revived, and thus we have now two Atlantic Companies in the field, and the great enterprise of the Indian Government to establish direct communication between this country and all parts of India.

With the Atlantic companies we have nothing now to do, except to say that the old company still adheres to the long deep-sea route from Ireland to Newfoundland, by which already so much money has been lost, and that the North Atlantic proposes to cross in several short lengths from Scotland to the Faroe Islands, and thence to Iceland, Greenland, Labrador, and so on to the mouth of the St. Lawrence, near Quebec. These rivals must settle the qnestion of their comparative merits with the public for themselves; but the Indian line is on quite a different footing. It has asked for no subscriptions, and makes no appeal to the public; it is a scheme which the Indian Government have undertaken of themselves, and which the success of the Malta and Alexandria line, managed under very much the same auspices, amply justifies them in taking into their own hands. Before this time twelvemonth the wire will be laid, and London, in point of time, within 12 hours' distance not only of Bombay, Madras, and Calcutta, but of the furthest limits of our Eastern Indian frontier beyond Rangoon! It is quite unnecessary to enter here into a consideration of the important questions which make it absolutely necessary that the Home Government should have a line of communication of their own to India. The reasons will suggest themselves at once to all our readers. It is also, perhaps, needless to explain how the mismanagement of the Red Sea line, which was never apparently made to work for long, and which was laid as if it was never meant to work at all, prevented that cable from supplying the wants of the Government. It is sufficient to say that the lesson which the Government and the Treasury then received warned them to undertake the matter themselves if they wished to prosper. The Indian Board have accordingly intrusted the entire superintendence and control of the whole plan to Colonel Patrick Stewart, R.E., as well known for his services during the Indian mutiny as for his labours in connexion with telegraphs throughout India. This gentleman has chosen Sir Charles Bright and Mr. Latimer Clark, electrical engineers, for the undertaking and for submerging the line. Every detail is now arranged, and the work begun, and, as, we have said, before this day twelvemonth we shall have our news every morning from India. Colonel Stewart has himself, during the last two years, travelled through and examined the various overland routes which have been from time to time suggested for a part of this line along the Turkish portion of Asia Minor. One of these has been selected from the greater ease with which land lines are erected and kept in repair as compared with submarine wires, and also because along at least three-fourths of the route the Turkish Government have already established, and keep in admirable working order, a telegraph from Constantinople to Bagdad. This land line runs from Scutari on the Bosphorus across Asia Minor to Diarbekir, thence to Mossul (the ancient Nineveh), and thence to Bagdad. It happens, however, that over the broad tract of country which intervenes between Bagdad and the head of the Persian Gulf, along which the submarine cable to India is to be laid, various predatory tribes of Arabs claim a sovereignty, and fight for it with more or less success; and over these lawless vagabonds the desert of the Porte has about the same control as Sir Joshua Jebb enjoys over his ticket-of-leave men. Always quarreling among themselves, they agree only on the one point of disobeying and defying their nominal lord the Sultan. These people will require skilful handling, and the land line from Bagdad will most probably be taken along the frontiers of Arabia, through the territories of the most powerful of the tribes, who are able to protect it against all comers, and whom a subsidy of £1,000 a-year will at once render most willing. By this route, for a length of some 300 miles, it will pass to the head of the Persian Gulf at the broad estuary which marks the junction of the Tigris and Euphrates—an eastern township called Shat-el-Arab.

It is not intended, however, to rely solely upon this route. Another land line will most probably be taken from Bagdad over the frontier of Persia to Teheran, thence to Ispahan, and so on by Shiraz down to the shore of the Persian Gulf at Bushire. Thus, even in the case of the Arabs ever proving refractory, there will always be the land line through Persia to Bagdad, and so on to Constantinople and England. From the estuary at Shat-el-Arab the submarine portion of the line is to be laid in three sections; for, though the length of the whole is only 1,010 miles, yet the Government have most wisely determined to avoid the dangers which always beset telegraphy through long deep-sea routes by making no less than three breaks at the stations at which the cable will be landed. The first length will be from the head of the Persion Gulf at Shat-el-Arab to Bushire, a distance of 170 miles, along which the cable will be submerged in from 20 to 25 fathoms of water. The next length will be from Bushire to Mussendom, a bold, desolate, stony headland on the coast of Arabia. This section will be 440 miles long, and submerged in from 30 to 35 fathoms of water. The third length will be from Mussendom to Guaddel, a small city on the Mekran coast, on the frontier of the Kelat territory. This portion will be 400 miles long, and laid in from 40 to 50 fathoms of water. From Guaddel, a short length of land line is now almost complete along the coast, giving direct communication with Kurrachee, and thence all over India. The submarine portion of the line is, of course, its most important part, and in the manufacture every care will be bestowed which the recent improvements in the science of telegraphy show to be advisable. The copper conductor is to be unusually large, composed of four segmental wires drawn into one—a new method, combining the advantages of a conductor formed of many strands, while obviating the drawbacks upon that mode of construction. This conductor is to be insulated with four coatings of gutta percha and Chatterton's compound, the whole insulating material to be wound round with broad tape or webbing, strongly bound on. Outside this again comes a "serving" of tarred hemp, and then the protecting sheath of iron covering of 12 large galvanized iron wires, to be wound on spirally. With ordinary cables the protecting covering would stop at the outer iron wires, but in this instance, as the line is to be laid in comparatively shallow water, the wires themselves, though galvanized, are to be still further protected from their most formidable enemy—rust. This is done most effectually by coating the whole cable thickly with two servings of tarred hemp yarn, overlaid with two coatings of a patent composition invented by Sir Charles Bright and Mr. Latimer Clark. The composition consists of mineral pitch or asphalte, Stockholm tar, and powdered silica, mixed in certain proportions and laid on hot. When

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quite cold this forms a massive covering of great strength and perfect flexibility, totally impervious to water, and incapable of being destroyed by the minute animalculæ which exist in such abundance in tropical waters. The weight of these main sections of the cable is about three tons per mile, but the extreme shore ends will be very massive, coated with galvanized iron-wire of almost tenfold strength, and weighing as much as 15 tons a mile. In certain portions of the route near Bussorah, where there is any danger to be apprehended from small coasters anchoring, the weight of the line will also be increased, by the extra thickness of its wires, to nine tons a mile—enough to shield it from any risk from anchors there. The contract for the manufacture of this cable has been given to Mr. Henley, of North Woolwich, who has undertaken to make it at the rate of not less than 50 nautical miles per week, and who, from the extent of his works, will propably be able to turn it out even faster. At every stage of its manufacture the electrical staff of Messrs. Bright are to test it for insulation and conductivity, and the standard below which it is not to be allowed to fall in either of these respects is fixed at nearly 25 per cent. higher in proportion than almost any cable has yet attained. In short, as far as depends on minute care and a wide scientific experience, the whole cable is likely to be as perfect as skill or ingenuity can make it. The vessels which are to take this line will probably leave England about the end of next June, arriving on the scene of their operations in the Persian Gulf in November or December the best time of the year in which to lay the cable. The process of submerging it and securing the shore ends is not likely to occupy, at the most, more than three weeks. The total cost of the submarine sections of the line will be less than £300,000, including the expenses of laying it.

TELEGRAPHIC COMPLAINT.

THE following appears in the *Times*:—

SIR,—Having written from the subjoined address to Gower Street, a letter containing certain instructions at 11·45 a.m. on Saturday last, and desiring to modify those instructions, I telegraphed from Highbury an hour and ten minutes later.

At 4 o'clock I had an answer by post that my first instructions had been carried out. At 8 o'clock the telegraphic message was delivered in Gower Street.

I have learnt a lesson; perhaps your readers may be glad to profit by my experience.—I am, sir, your obedient servant,

GEORGE BUCHANAN, M.D.

6, Northampton Park, N., Dec. 29.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

TRAIN SIGNALLING.

SIR,—I should be glad if Mr. Rudall would inform your readers in what respect his system differs from Mr. C. V. Walker's, and how far he considers it to be superior to Tyers, when he adopts Tyers' bells without Tyers' indices—indeed entirely Tyers' goose without the stuffing. We are always glad to hail improvements and progress, but are decidedly opposed to retrogression and inefficiency. Mr. Rudall's plans is certainly no improvement upon existing systems. Ten signals appear ridiculous where two or three are only required; and to require touching distinct currents to give a signal which usually only demands one is anything but simple. It is very questionable whether such a system would ever be sanctioned by the Board of Trade. Mr. Edwin Clark has very ably laid down the requirements of a signalling telegraph (v. p. 195, vol. ii.), and no system should be encouraged which does not strictly fulfil these conditions. Mr. Rudall's bells fall very far short of them. A SUPERINTENDENT.

To the Editor of THE ELECTRICIAN.

SIR,—The Indian Council have decided on a submarine cable across the Persian Gulf. They have not given over this national work to any company, contractor, or concessionaire. The whole management of this undertaking is intrusted to one of their own officers, Colonel Stewart, R.E.

The core will be gutta percha, made at the Gutta Percha Company's Works, Wharf Road; it will be tested by Reid's process of pressure, equal to the depth of sea where the cable is to be laid. Mr. Henley, of North Woolwich, will make the iron sheathing, and our own Government ships will submerge it.

From the specimens already constructed, it is admitted to be the best submarine cable yet made, and there is no doubt it will prove so. The whole cost will be about £30,000. GALVANI.

To the Editor of THE ELECTRICIAN.

SIR,—Will you allow me to correct an error which I find in my letter you kindly published last week on "Train Signalling. The manufacturer of the bells is Mr. "Izant," not "Bryant."—I am, sir, your obedient servant, F. RUDALL.

London, December 30, 1862.

PATENTEES AND TELEGRAPHY.

To the Editor of THE ELECTRICIAN.

SIR,—It is well known that the "*speculative engineer*" played a distinguished part in our past telegraphic failures, especially with respect to the Atlantic and Red Sea Submarine Telegraph lines. We are now about constructing a cable to be submerged in the Persian Gulf, the engineers of which are likely to be well remunerated for their *patented inventions* in the shape of a singularly ill adapted conductor, which will bear no kinking and an external protection for the wires. How completely the recommendation of the Government Commission is ignored by those gentlemen.—Yours, &c.,

L. C.

To the Editor of THE ELECTRICIAN.

DEAR SIR,—I am very desirous of knowing accurately the mileage of telegraphic line and wire throughout the world; and you would much oblige if you could reconcile the following apparent discrepancies.

Vol. I., p. 272, in a lecture given by Mr. Preece at the Lymington Literary Institution, the following figures are given:—"Miles of telegraph" (*query*—wire?) "in England, 1845, 500; 1850, 1800; 1855, 3,400; 1862, 60,000; in America, 40,000; in Europe, 30,000; and in British dependencies, &c., 15,000"—equal to 145,000 miles.

Again, Vol. I., page 150:—"Sir Charles Bright on the State and Progress of Telegraph Operations." He says, "At the present time we have in Great Britain and Ireland 15,000 miles of line. * * * There is now 15,000 miles of line in Great Britain, as well as 48,000 in the United States, and 80,000 on the continent of Europe: total, about 150,000 miles."

The totals thus nearly agree; but the discrepancy in the particulars is remarkable. Can you tell me which is correct? *both* cannot be.

Please, also, give me advice in *this* matter:—In Vol. I., p. 259, is described "Callan's single fluid cast-iron battery." I have 12 cells of Maynooth, which I never used, on account of the immense amount of nitric acid they used, and of the fumes evolved; but when I saw this new arrangement, I was pleased to think my iron pots would be of some use, after all. But I find the evolution of hydrogen, if possible, more offensive than that of the nitrous acid; and the acid boils over the sides, and walks into the binding screws most objectionably; besides which, after about half an hour, the whole thing becomes nearly solid, and on standing a short time, I got a regular mould of sulphate of iron! Something is wrong somewhere.—Yours obliged, A. H. B.

January 30th, 1862.

Telegraphic News.

METROPOLITAN RAILWAY TELEGRAPH.—On Saturday last, the 27th inst., the electric telegraph and semaphore signals, in conformity with the recommendation of Colonel Yolland, the Government Inspector, were adjusted, and should they, on a further inspection, be found satisfactory, the certificate of the Board of Trade will be granted for the opening of the line.

LONDON DISTRICT TELEGRAPH COMPANY.—In London during the severe storm of last week a great portion of the wires connected with the London District Telegraph Company were blown down and destroyed from the western end of the Whitechapel road to Mile-end-gate. Some hundred of yards of wire were caried into the main thoroughfare, when Mr. G. Macksey, the telegraph stationmaster at Mile-end, accompanied by a number of police of the H and K divisions, proceeded to the spot and collected and conveyed it to the Leman Street Police Station and the office of Mr. Macksey. The telegraphic communication in this district is at present interrupted, but no doubt, in a few days, the wires will be repaired by the company.

TOULON AND ALGIERS CABLE.—An unsuccessful attempt has been made to raise this cable near the French coast. It is stated that endeavours will now be made to underrun the cable from the coast of Algiers.

Miscellanea.

IMAGINARY (RAILWAY) CONVERSATIONS.—The perusal of the Electric Telegraph, if we could trace in those lines what they are talking about, would, we are sure, furnish a most amusing volume of miscellanies.

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When we see the wire vibrate with a thrilling motion, we can fancy that it bears some ecstatic message from some ardent lover, and we see in our imagination, the

"Soft intercourse from soul to soul,
Wafted along from pole to pole,"

as it passes from one station to the other. Filled with these sentimental reflections, we rushed into the telegraph-room at a London terminus, and made it an earnest request that we should be admitted to the confidence of that electric communicator, so refined and "air-drawn," like *Macbeth's* dagger. Our entreaty was answered with ready acquiescence, when to our utter horror the question asked, was, "How are you off for coals?" and the answer returned, was "Pretty well, thank you."—*Punch.*

ONE of the most remarkable phenomena of the present day is the introduction of the highest achievement of art and civilization into the waste places of the earth; as, for example, a railway and telegraph across the Egyptian desert, along the dreary shores of Newfoundland, and other places. The wires are now making another stride across North-eastern Europe, for the Russian Government, desirous of speedy communication with China, and their settlements on the Amoor, have already carried their wires as far as Tomsk in Siberia, whence they will be extended to Iskutsk in the course of next year, and onwards to the furthest Russian station on the frontier, Kiatcha. From the latter place the messages will be sent on to Pekin, by the carriers who convey the official correspondence of the Government, until the time comes when the wires shall be stretched all the way to Pekin.—*Chamber's Journal.*

SUBMARINE BLASTING.—At the new pier in progress of construction at Havre, engineers are now employed in removing the foundations of the tower of Francis I., and they take advantage of the high tides to spring the mine then covered with water. The engineers no longer make cavities in the submarine rocks to contain the powder, they merely place a large glass bottle, inclosed in a basket, at the bottom of the sea where they mean to act, and this bottle is filled with gunpowder in proportion to the effect to be produced. The pressure of a column of water of some feet is sufficient to compress the gas so powerfully as to cause great ravages where the basket is placed, even were it the hardest granite. The gunpowder is ignited by electricity.

PERSIAN GULF CABLE.—The materials will be about 2,500 tons of wire, 4,000 miles of tape, nearly 300 tons of hemp, between 200 and 300 tons of silica, about 130 tons of pitch, and 1,000 barrels of tar, besides the core, consisting of 225 pounds of copper wire, and 275 pounds of gutta percha per nautical mile. The length of cable to be manufactured by Mr. W. T. Henley is 840 nautical miles of main cable, 35 nautical miles of shore end, together 875 nautical miles. The manufacture of the cable is to commence within 21 days after the tender is accepted, and to be completed within 15 weeks after it is begun. After the first few weeks have elapsed, not less than 50 nautical miles a week must be made.—*Herepath.*

ANTIDOTE FOR CHLOROFORM.—A distinguished physician in Paris, Dr. Robert De Lambelle, announces that a shock of electricity given a patient dying from the effects of chloroform immediately counteracts its influence and restores the sufferer to life.

COMBUSTION OF IRON UNDER MAGNETIC INDUCTION.—The following curious fact is extracted from a pamphlet by Professor Nicles. It is well known that iron which is obtained by reducing the oxide by hydrogen gas at a high temperature has so great an affinity for oxygen as to take fire spontaneously in the air. Iron in a state of fine division, but obtained, for medical purposes, by mechanical means, *i. e.*, by the aid of very fine files, will not take fire even when a lighted match is approached to it; but if the metallic powder be previously placed on the poles of a magnet it will burn vividly. Mr. Nicles states, however, that this property is limited to iron prepared in the Tyrol, more or less.

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By Order,

22, Old Broad Street, London.

GEO. SAWARD, SECRETARY.

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The Electrician.

VOL. III. No. 62.—JANUARY 9, 1863.

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ON THE ECONOMICAL APPLICATION OF A VOLTAIC CURRENT IN THE PRODUCTION OF SECONDARY BATTERIES.

BY far the most powerful voltaic combination with which we are acquainted is formed of an amalgam of potassium or sodium as the positive element, with a strip of platinum in nitric acid, or other oxidizing medium, as the negative. A very manageable couple, in which potassium or sodium is used, was contrived by Mr. GOODMAN, and is described in Vol. VIII. of the "Memoirs of the Manchester Literary and Philosophical Society." A similar arrangement, in which precaution is taken against the polarization of the platinum, will be found very convenient by the experimentalist; as by means of one cell the decomposition of water is rapidly effected, and an appreciable charge even communicated to the electrometer. Indeed, we are of opinion, that it might be employed with advantage for military telegraphs, and under other circumstances where economy of space and trouble is desirable. Prior to entering upon some considerations which the use of this combination has suggested, we may, therefore, briefly indicate the mode in which the couple in question may be constructed.

A small glass jar is fitted with a cover of gutta percha or wood, through which two holes are made of sufficient size to take two short pieces of glass tubing, the lower extremities of which are intended to dip into dilute sulphuric acid contained in the jar. These extremities are to be plugged with a porous diaphragm, by running into each tube a very small quantity of fine plaster of paris in admixture with water. In one of the tubes may now be placed a few drops of mercury, to which is added four or five grains of metallic potassium or sodium. The latter combines with the mercury, forming an amalgam, the external oxidation of which is prevented by covering it with a small quantity of the mineral naphtha, in which the alkaline metal should be kept. The other tube contains a small quantity of nitric acid, in which is immersed a platinum wire, flattened out at its extremity, that it may present a larger surface. The upper extremities of the tubes may be fitted with a plug, or cover, of gutta percha, through which is passed a small binding screw connected in one case with the platinum wire, and in the other with a piece of wire through which contact is made with the amalgam. When the couple is not in use, the two tubes are withdrawn from the dilute acid in the glass jar, and when an experiment is to be made they are lowered into the fluid, in which case only the amalgam is exposed to oxidation. Other arrangements may be adopted for practical purposes, and to these we shall have occasion shortly to refer.

But what we have most interest in pointing out is, that the electrical experimentalist, having at command the most powerful agency of decomposition and synthesis, need not have recourse to the chemist to obtain the intensely electro-positive body employed in the above combination. Indeed, he may readily occasion its formation, with very little expenditure of force or material, by exacting chemical as well as mechanical work from any electro-motor he may have occasion to employ for the deflection of a needle or the excitation of an electro-magnet. By the means we will describe, he may utilize a current for the production of this compound, with little expenditure beyond that of the chemical equivalent of zinc corresponding to the potassium or sodium actually obtained in combination with mercury.

The alkaline metals are not to be obtained on such easy terms by simply forming a secondary battery with platinum and mercury, in contact with a potassa or soda salt and traversed by the current, as may occur to many of our readers. If, however, for the platinum we substitute, *pro tem.*, a strip of zinc, the necessary conditions are fulfilled. But we must simplify somewhat this digression *ad adeptos*.

Let us suppose we are using a battery, of which the negative pole is connected to earth, for the transmission of electrical signals. We take the apparatus above described, for the employment of the alkaline metals in a voltaic couple, and we replace the sulphuric acid in the glass jar by a handful of common salt, or of the chloride of potassium, moistened with water. We replace, also, the amalgam in the disconnected tube by pure mercury, covered with naphtha. We than attach the positive pole of the battery to the platinum element of the couple, and we connect the wire in contact with the mercury to the line through which we are signalling. The signals received at the distant station will not, at the outset, be greatly weakened by the resistance we have interposed in the circuit,—a resistance which we might, if necessary, greatly reduce by employing larger surfaces in the arrangement we are now using for the purpose of obtaining a "secondary battery." In a short time, however, our secondary battery will have become active, through the decomposition of the salt and the formation of an amalgam of sodium or of potassium. A powerful couple will thus be in opposition to our working battery; and we shall retain our secondary couple with a very considerable expenditure of voltaic force, and under conditions which are far from being favourable in an economic point of view.

Let us now withdraw from contact with the salt the tube containing nitric acid and the platinum element, and let us substitute for this element a strip of zinc immersed in the moistened salt. The line wire, as before, is to be connected to the mercury cell, and the positive pole of the battery is to be brought into contact with the zinc. The first thing we shall observe, by means of an indicator placed in circuit, is that the current is actually strengthened by the addition of our secondary couple or couples. In fact, the mercury and zinc constitute an active voltaic arrangement, which is so connected to the working battery as to increase its tension. The strength of the current will, however, rapidly diminish, becoming first equal to that of the working battery, and ultimately slightly, but perhaps almost imperceptibly, weaker than the latter. Our secondary battery will have become active by the production of an amalgam of potassium or sodium at the cathode within the cell, and it will be opposed to the current from the working battery. But, as the electro-motive force of a couple composed of zinc, as a *negative*, with amalgam of potassium or sodium as a positive, is almost *nil*, our working current will be but very slightly weakened. Our main expenditure, therefore, is in zinc consumed at the anode within the secondary cell. Of this metal, 32·5 parts by weight is the chemical equivalent of 40 parts of potassium, or of 24 parts of sodium, separated at the cathode.

In the secondary couple, when used for the generation of a current, the strip of zinc is replaced by the platinum element; and, as we have seen, a very powerful electro-motor is thus constituted. The current from this may, by similar means, be made to render active another secondary combination, while producing also a mechanical effect; and, though the economy of voltaic force, by the application of this principle, is practically confined within narrow limits, it becomes an important element of calculation in determining the amount of mechanical work capable of being per-

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formed by voltaic agency, with a given consumption of material. In this problem, the secondary effects due to the chemical reaction of the current, and the mode of utilising these effects, have not yet been considered. They are, nevertheless, of the greatest interest to the physicist, and offer an opportunity for useful research and discussion, which will doubtless be welcomed by our practical readers.

ON THE POSSIBILITY OF ASSIMILATING MARINE TO AËRIAL ELECTRO-TELEGRAPHY, BY THE SUPPRESSION OF RETARDING INDUCTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 97.)

DAVID esteemed his *pebbles from the brook* more promising than all the *unassayed armour* of his sovereign, but he passively buckled the sword upon his thigh notwithstanding. So, as the ELECTRICIAN remarked last week, telegraphists will be wise in declining to go against their Atlantic giant unfurnished with the means they have amply proved and adopted upon almost unanimous authority; but it would be no part of their wisdom to ignore the possibility of auxiliary appliances, or to leave them behind when, at least, their presence would not be detrimental. Suppose, for example, the Atlantic Telegraph Company, while scrupulously embodying in their projected cable all the desirable points that were established before the Government Committee, could add to them certain others, not established by the evidence, but plausible on the grounds of argument, would they act like men of business in passing them over? Yes, they would, at this particular juncture, if the presence of the new features could possibly damage the old ones; but no, they would not, if the presence of the new points must be harmless. There will be, at the close of this essay, a question of that sort to be considered.

We know that the charge flowing into, and away from, a marine wire each time it conveys a signal, is enormously greater than for the aerial wire; and as that larger quantity must be multiplied by the squares of the lengths of the wires in the one case as in the other, the time occupied in providing and getting the total in and out of a very long marine wire becomes a most important hindrance to the rapidity of signalling along it. One way of diminishing the hindrance is to reduce the vastness of the charge, but there are also other available means for contributing to the same end; and, to apply all with effect, we ought first thoroughly to know the theory of the hindrance, or, as it is technically called, the retardation of the signals. The same electrical action which has enabled us to understand how uninsulated conducting matter confers capacity for charge on the wire of a marine cable that it surrounds, will enable us to trace also, circumstance by circumstance, what further remains to be comprehended.

Retardation may be caused by two different things:—first, resistance or inertia, which diminishes the velocity of electricity in motion; and, secondly, want of conductivity, by which no more than a certain quantity of electricity can pass through a given place at one and the same time. Induction is the *remote cause* of retardation, inasmuch as it increases the quantity of electricity needing to pass through a conductor with each signal transmitted.

To investigate the nature of resistance, let us take an aerial wire and a marine conductor of equal lengths—each in communication with an uniform and never-failing source of electricity at one end—its other extremity being uninsulated. The intensity of induction, acting both for conduction and for charge, being the same in both cases, the charges will consist of quantities very unequal, as determined by their respective charging capacities; and the resistances to the passage of electricity along the wires, being relatively as the quantity in motion multiplied by the lengths passed through, will be much more considerable in the marine than in the aerial wire. Beside these resistances, which are common to the two cases, albeit greater in one than in the other, *there is also another peculiar to the wire of the cable*, —not within it, but *around it*. We are to recollect that while induction sets free only *virtually* the natural electricity of the insulating air around an atmospheric telegraph, it liberates *actually* the electricity from the conducting water in which the marine telegraph wire is immersed; and, on our principles, it is quite certain that the liberated electricity cannot remain as an induced plus charge in the middle of a mass of water, like as it does in the air, but must pass through the water either to its surface, to act there by induction, if the locality around be electrically neutral, or else in some other direction leading to a place where the earth or water is (by reason of meteorological changes) for the moment in a minus electrical condition. This passage of electricity through the water will necessarily be followed by a *return movement* on the discharge of the wire, only for the motion in both directions to be again repeated alternately so often as the wire shall be charged and discharged. This oscillating movement is a source of considerable resistance, and there is no special motive tension provided for actuating it; it is simply and purely so much more hindrance to be overcome by the motive tension acting along the wire; nor would it be the less so if the induction fell upon a metallic cylinder, surrounding the charge, and cut off from conducting communication with the water, for in that case one of two things must occur—either the inductive action would simply pass through to the water as before, or, in addition to so doing, it would send electricity on to the signalling instruments at the end of the wire. The proposition which has sometimes been made to signal by means of induced charges is, therefore, not only destitute of promise, as Mr. LATIMER CLARK has said, but it would positively inflict a disadvantage; for while it would leave the quantity of electricity needing to be moved, and also the motive tension, unaltered, it would add considerably to the course over which the movement would have to take place. All expectation of good from this source should therefore be abandoned.

To save time in signalling, we should aim at pouring simultaneously into the end of a marine wire the whole quantity of electricity it requires. This, however, cannot be done, for two reasons: in the first place, we cannot have a sufficient quantity of electricity accumulated in readiness to be poured in by a sudden discharge of the voltaic apparatus; and, if we could, no wire of practicable size would be competent to receive it all at the same instant of time; it could only enter by a number of successive pulsations of the conducting action, each one engaging the conductivity, under the existing intensity, of the whole sectional area of the wire. The term *pulsation*, as here used, is perhaps not strictly expressive of the physical fact; nor is it meant to do more than convey an idea of consecutive parts which might not be otherwise easily represented. We may conceive pulsations to follow each other so rapidly as to be continuous; but still they may each be supposed to occupy a distinct portion of time, their duration as a whole being commensurate with the quantity of electricity they discharge into the wire.

A large wire is to be preferred to a smaller one; it is an evil in so far as it inherits a greater capacity for charge, without any influence in reducing resistance or increasing velocity; but then it possesses a greater conductivity, permitting the simultaneous ingress and egress of a larger quantity of electricity, far beyond what is necessary to compensate for the larger charge it demands; it allows a conductive pulsation to be of greater magnitude. The charging capacities of the wires in marine cables, all other things being equal, are said, by the reporters to the Telegraph Committee, to vary as the square roots of their diameters, while their conducting powers are as the squares of the diameters. To have the full advantages of a large wire demands, on the principles we are applying, *that its diameter should be maintained throughout its entire length*, even in the coils of the instruments through which its extremities communicate with the earth, for no homogeneous

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wire can have a greater conductivity than its smallest section. This will need a remark in elucidation, and it may be furnished by a brief analysis of any charged main wire. When electricity is permanently passing in at one end of a telegraph conductor and out at the other, the resistance which the wire opposes to its passage may be represented as a wave having a certain height where the electricity enters, and tapering off to nothing at the other extremity. The resistance taken at successive points, following each other at regular intervals, would thus be shown to diminish progressively as the numbers 25, 16, 9, 4, 1; and the velocity, being inversely as the resistance impeding it, will be (the motive tension being constant) as the series one, one nine-sixteenths, two seven-ninths, six and a quarter, twenty-five. But if unequal velocities obtain in different parts of the same wire how is it that no more electricity leaves the wire than enters it, which of course is a question that the theory must satisfactorily answer? The answer is, that, precisely as the resistance in the wire falls, so falls with it the intensity of induction, and the conductivity of the wire depending upon that intensity, so that the velocity and the conductivity, taken at any point of the wire, and multiplied into one another, give the same product. Thus, $25 \times 1 = 16 \times 1$ nine-sixteenths $= 9 \times 2$ seven-nineths $= 4 \times 6\frac{1}{4} = 1 \times 25 = 25$. Now, to apply this to what I have said about the necessity for maintaining throughout a cylindrical and homogeneous telegraph conductor an undiminished diameter we have only to reflect that at no part of its length is its sectional area more than inversely proportional to the conductivity there existing; if, therefore, the sectional area be made less, the conduction will be proportionately arrested.

The size of a telegraph conductor should increase with its length. or a longer period will be occupied in getting its greater quantity of electricity in and out of it; but it need not be larger in diameter by reason of increased intensity of the passing electricity, as intensity makes a way for itself, by augmenting the conductivity of a wire in the exact proportion required.

Intensity has the same influence on the charging capacity of a wire that it has on its conductivity. The quantity of electricity accumulated at the pole of an insulated battery increases in simple proportion with its number of elements in series; but whether the quantity thus accumulated be great or small, it will equally all find place upon a wire, for the intensity will be as the square of the quantity thus accumulated, and the charging capacity as the square root of the intensity.

But after we had provided by ample conductivity for the ready passage of electricity into, and out of, our marine telegraph cables, we should still have to contend with the resist ances that have been described, unless we could find a means of making a smaller quantity of electricity suffice for charging them. We cannot with impunity do this by lessening the intensity of our voltaic source, because motive tension would diminish with the intensity in a much more rapid ratio than the quantity of electricity would do; and with lower motive tension we could only less effectually combat resistance and promote velocity. What we want to do is to leave the intensity as high as we can safely work it, while we reduce the charging capacity of the wire, under that intensity, to the lowest possible minimum; and now that we know the principles of action on which charging capacities are conferred, let us see what in this direction we may find possible to be done.

Part of the action of the ordinary marine cable is as follows:—One of the extremities of its conductor being put into permanent communication with a voltaic battery (the other extremity being, we may for greater simplicity suppose, insulated) electricity enters the wire until there be enough upon it to act with the utmost intensity that can be conferred by the source. Some portion of the charge acts by induction upon the proximate surface of the solid material by which the wire is insulated; the induction, propagated particle by particle through the solid substance, terminates on the hollow cylindrical surface of the surrounding conducting water, from which is set free a quantity of its natural electricity, represented by that portion of charge on the wire which has initiated the *propagation* of induction. When the specific inductive capacity is great, the charging capacity it confers, and consequently the charge entering upon the wire under its influence, is great in proportion; and if the water be brought to one-fourth the distance, the charge due to propagated induction is, from that cause, again doubled. But while this action is taking place, another also is not only possible, but, with the arrangements adopted in practice, inevitable; for the cylindrical surface of the water nearest to the wire has its specific indicative capacity also, and induction acting directly upon it, will confer a charging capacity, though it must necessarily be depreciated in amount by the length of interval across which the induction is projected. Charging capacity from this cause would be exactly measured by the quantity of electricity liberated from the water by the *projected* induction, setting out with the intensity existing at the source and progressively falling in conformity with the law of distance. If the water would have no electricity left in it held by so low an intensity of attraction as that which could arrive, there would be no liberation of electricity by projected induction, and no additional capacity for charge thereby conferred on the wire; if, on the contrary, the water had much electricity so feebly held, great, in consequence of the projected induction, would be the accession of charging capacity by the wire. Now, therefore, whether there shall be, or not, charge by projected induction, must be altogether a question of intensity on the one hand, and of distance on the other.

And there is one consideration of importance that I wish to impress on the minds of my readers—they can follow it out at their leisure: charging capacity of the wire increases with the intensity of its charge, because of the increased intensity of its induction—both contiguous and distant; but it is the latter only that can provoke what FARADAY has called *disruptive* discharge, as that alone has any intervening obstacle to break through. The former is assimilated in its nature to conduction.

To lessen the quantity of electricity needed to charge our marine telegraph conductors, we must, therefore, more economically manage our inductions; first, as they relate to insensible distances, or the continuous action of FARADAY; and, secondly, to the distances of sensible and unlimited magnitude, which COULOMB had in contemplation. If we put out of consideration for a moment the law of electrical attraction as regards distances, and confine our attention to the propagation of induction among the particles of common matter that are most contiguous to one another, we shall come at once to two easy conclusions: we may lessen the charging capacity of a marine wire by surrounding it with a given thickness of solid insulator of inferior specific inductive capacity, and the material being given, we can, by increasing its thickness four times, reduce the charging capacity to one-half. These are important advantages, but there is a greater relating to the law of distance which also must be considered; and it may be simply announced by saying, that the portion of charging capacity conferred upon a marine conductor by projected induction, falls to its one-fourth part on interposing between the wire and the water four times as long an interval, which of course we shall interpose by intruding the solid insulator that we use for reducing to one-half the capacity by propagated induction.

This will suffice for the theory of the proposed improvements of the marine electric telegraph, and from it we may obviously derive the following

PRACTICAL MAXIMS.

The conductor of a marine cable cannot have too large a sectional area, provided it be not too great to be maintained without diminution throughout the whole telegraphic line, magnetic instruments included, from earth at one station to earth at the

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other. Increased sectional area will demand the entrance and exit of larger quantities of charge, but it will pass the larger quantities in and out in a shorter time.

Coils around magnets may, with equal advantage, be of shorter wire proportionately thick, provided its sectional area be at the existing intensity wholly occupied with each conductive pulsation; because, when equal quantities of electricity are rotating within a given distance, the magnetic effects are equal.

Conduction should be actuated by an intense voltaic series. Increase of intensity increases *conductivity* in its own ratio, enabling electricity in proportion to arrive at the signalling instruments with each conductive pulsation.

One end of a conductor being to earth, the *conduction* along it will be more rapid as its other end is more intense; because the greater will be the motive tension throughout its length, and the more numerous the conductive pulsations in a given time.

Both ends of a conductor should be equally intense; one with plus, and the other with minus charge. The motive tension will thereby be doubled, and each conductive pulsation occupy only half the time.

The insulator around the conductor should have a minimum of specific inductive capacity, and a maximum of thickness; for as the former is less and the latter is greater, so will the charge accumulated under any given intensity decline in quantity, and the resistances opposed to a given motive tension become less important.

CONSTRUCTION OF CABLE.

The conductor, being made of a large wire, or strand of wires, and insulated with gutta percha or caoutchouc, with the usual precautions, is to receive an outer covering intended to serve, not merely the purpose commonly understood, but some additional purposes as well; for, among other things, it is to put far away from the conductor all uninsulated conducting matter, to confer upon the cable considerable tensile strength under any desired specific gravity, and to give it flexibility with innate power to avoid elongation, untwisting, and kinking.

The covering is to consist of hempen strands, some with a right-handed and others with a left-handed tension, made electrically insulating, first, by exposure to a temperature above 212° Fah. until they have parted with the whole of their hygrometric water, and then by immediate immersion and saturation in a hot bath of desiccated resin, so tempered with beeswax, caoutchouc, or other efficient substance, as to confer upon the solid, when cold, tenacity and flexibility. The saturated strands, very tightly twisted, are to be put spirally round the core in alternate layers of right and left-handed, each being crossed by the next above it, and the whole forming a firmly-compressed body, made by the cement impermeable to moisture. The superposition of the crossing spirals is to be continued until the cable has acquired the greatest diameter permissible in the particular case; each of the two outermost layers of strands having one or more iron wires worked into it, in place of so many hempen strands, for the sake of securing the particular specific gravity desired, and, at the same time, incidentally, additional strength. When the whole is put together, the cable should be finally passed through the hot cement bath, then served with yarn soaked in the cement or tar, and the shore ends mailed as usual.

It is anticipated that the insulating hempen covering thus put on would effectually obviate "faults" in the inner insulator, and be itself impervious to water under pressure. And should moisture even penetrate to the core in certain ill-constructed places, it would militate but little against the electrical utility of the cable, and nothing against its mechanical qualifications; such a cable, if it ever needed repair, would probably, from its buoyancy, be recoverable from the greatest depths, and in no respect could it be less promising than one of ordinary construction, which, in fact, it would carry within it and protect; and the number of words it would transmit, when properly made, and worked on the principles explained, would, there is reason to believe, be limited only by the powers of the persons deputed to work it.

CONCLUSION.

And now one little word to finish with. Critics have concluded that if "Cæsar never did wrong but with just cause," he was innocent of wrong altogether. Writing in the way I have just done, may be thought "obstructive," but then what has been said may be true, and if true, it can hardly be wrong. Of that telegraphists can form their own opinion on their own responsibility. I would rather aid than hinder any enterprise that is to unite us telegraphically with America; but I recommend circumspection, emulating the old moralist:—

> "My zeal is far too real to stop to hurry,
> For hurry times, as well as rhymes, with flurry!"

Impelled by a commercial impulse to secure a fleeting position, the promoters of the first Atlantic Telegraph did not take time not to be in a flurry, but the promoters of the second may recover the position without following their example; they have time to be circumspect, and, if they choose, may take with it, what their predecessors could not have, *a minute and consistent account of the principles involved in their undertaking.*

ERRATA.

Our readers are requested to make the following corrections:—

Page 87, column 1, line 25, for "motive tension and therefore the resistance being the same without improvement in velocity," read, *intensity in the wire.*

Same column, line 21 from the bottom, for "resistance multiplied by the motive tension," read, *motive tension divided by the resistance.*

Page 97, last paragraph of the essay; read the five concluding lines as a continuation of the antecedent paragraph.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued).*

1838—ARAGO.—

[Annuaire pour l'an 1838, presenté au Roi par le bureau des Longitudes. Suivi d'une, Notice sur le tonnerre. Par M. Arago. Paris: Bachelier, Imprimeur Libraire du bureau des Longitudes et de l'Ecole Polytechnique, Quai des Augustins, No 55, 1837.]—12mo.

Contains, from page 220 to 618, Notice sur le tonnerre, par M. Arago.

1838—HIGGINS, W. Mullenger.—

[The Experimental Philosopher. By Mullinger Higgins. Author of "The Earth," &c. London: Whittaker and Co., Ave Maria Lane, 1838.]—1 vol, small 8vo.

Contains: Chapter vi., "Magnetism;" chapter vii., "Common Electricity;" chapter viii., "Voltaic Electricity;" chapter ix., "Magnetic and Thermal Electricity," &c.

PARTINGTON, Charles F.—

[A Manual of Natural and Experimental Philosophy, being the substance of a series of Lectures, delivered in the London, Russell, Surrey, and Metropolitan Institutions. By Charles F. Partington, author of a "Historical and Descriptive Account of the Steam Engine," "Gallery of Science," &c. &c. Illustrated by four copper plates, and two hundred and seventy engravings on wood. London: Orlando Hodgson, 111, Fleet Street.]—8vo., no date.

There is a first addition dated 1828, but this is later than 1838, as it refers to the ascent of the "Montgolfier Balloon" from the Surrey Gardens, on the 31st of May, 1838. Page 248, "Simple Electrical Phenomena;" page 274, "Atmospheric Electricity;" page 284, "Voltaic Electricity;" page 306, "Magnetism;" page 226, "Electro-magnetism."

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1839—DAVY Sir Humphrey.—

[The collected works of Sir Humphrey Davy, Bart., LL.D., F.R.S., Foreign Associate of the Institute of France, &c., edited by his brother, John Davy, M.D., F.R.S. Vol ii., Early Miscellaneous Papers. London: Smith, Elder, and Co., Cornhill, 1839.]—8vo.

Contains: Papers vi. to xvii. on "Voltaic Electricity." Also Lectures delivered at the Royal Institution of Great Britain. Part ii., division iii., on "Electric Influences;" division iv., "Of Galvanism."

1839—ANONYMOUS.—

[The Companion to the Almanac or Year-Book of General Information for 1839. London: Charles Knight and Co., 22, Ludgate Street.]—Small 8vo.

Contains an article on "The Electricity of the Atmosphere," pages 8 to 24.

1839—FARADAY, Michael.—

[Experimental Researches in Electricity. By Michael Faraday, D.C.L., F.R.S., &c. Vol i., reprinted from the Philosophical Transactions of 1831-38. London: Richard and John Edward Taylor, printers and publishers to the University of London, Red Lion Court, Fleet Street, 1839.]—8vo., plates and woodcuts.

There is a second edition of this work, dated 1849, but it appears to be only a reprint, since the preface is still dated 1839.

1840—THOMSON, Thomas.—

[An outline of the Sciences of Heat and Electricity. By Thomas Thomson, M.D., Regius Professor of Chemistry, in the University of Glasgow, F.R.S., &c. &c. Second Edition, remodelled and much enlarged, and illustrated with woodcuts and maps. London: H. Bailliere, foreign bookseller and publisher, 219, Regent Street. Paris; J. B. Bailliere, 13, Rue de l'Ecole de Medicine. Liepsig: T. O. Wigel, MDCCCXL.]—8vo., 577 pages.

Pages 291 to 577 on Electricity.

1840—ROBERTS, Martyn J.—

[The process of blasting by Galvanism, detailed in a letter addressed to the Highland and Agricultural Society of Scotland. By Martyn J. Roberts, F.R.S.E. London: Longman, Orme, and Co.; and Grant and Son, Edinburgh, MDCCCXL.]—Pam., 8vo., 36 pages. Plates.

1840—SPENCER, Thomas.—

[Griffin's Scientific Miscellany; an occasional publication of Treatises relating to Chemistry and the other experimental Sciences. Instructions for the multiplication of works of art in metal, by voltaic electricity. By Thomas Spencer. Glasgow: published by Richard Griffin and Company; and Thomas Tegg, London, MDCCCXL.]—8vo., 62 pages. Cuts.

This, evidently by a printer's error, is dated 1940.

1840—DAVY, Sir Humphrey, Bart.—

[The collected works of Sir Humphrey Davy, Bart., LL.D., F.R.S., &c. Edited by his brother, John Davy, M.D., F.R.S. Vol. iv., Elements of Chemical Philosophy. London: Smith, Elder, and Co., Cornhill, 1840.]—8vo. Plates.

For Electricity, see pages 91, 852, 362. Originally published in 1812.

1840—DAVY, Sir Humphrey, Bart.—

[The collected works of Sir Humphrey Davy, Bart., LL.D., F.R.S., Foreign Associate of the Institute of France, &c. Edited by his brother, John Davy, M.D. F.R.S. Vol. v., Bakerian Lectures and Miscellaneous Papers, from 1806 to 1815. London: Smith, Elder, and Co., Cornhill, 1840.]—8vo.

Contains a great deal upon Electrolysis, &c.

1841—

The Transactions and the Proceedings of the London Electrical Society, from 1837 to 1840. Edited by one of the Committee. London: published by Smith, Elder, and Co., Cornhill, 1841.]—4to., 204 pages. Plates.

1841—DE LA RIVE, A.—

[Archieves de l'Electricité. Par A. De La Rive, Professeur de Physique à l'Academie de Geneve. Supplement à la Bibliothèque Universelle de Geneve. Tome 1, Année 1841. On souscrit à Geneve, au bureau de la Bibliothèque Universelle, Chez B. Clarer, Rue de la Pelisseru, No. 133. Paris: Chez Anselin, Successeur de Magimel, Rue Dauphine, No. 36, 1841.]—8vo., 672 pages.

1841—LARDNER, Dionysius, Dr.—

[A Manual of Electricity, Magnetism, and Meteorology. By Dionysius Lardner, D.C.L., F.R.S. In two volumes. London: Longman, Brown, Green, and Longmans, Paternoster Row, 1841.]—Illustrated, 438 pages.

1842—STURGEON, William.—

[Lectures on Electricity, delivered in the Royal Victoria Gallery, Manchester, during the Session of 1841-2. By William Sturgeon, Superintendent and Lecturer of the Royal Victoria Gallery of Practical Science, Manchester, &c. London: published by Sherwood, Gilbert, and Piper, MDCCCXLII.]—Small 8vo. Woodcuts.

1842—STURGEON, William.—

[The Annals of Electricity, Magnetism, and Chemistry, and Guardian of Experimental Science. Conducted by William Sturgeon, &c. London: 1837.]—

This is the 8th and last volume. See also 1837.

1842—COOKE, William Fothergill.

[Telegraphic Railways, or the single way recommended by safety, economy, and efficiency under the safeguard and control of the Electric Telegraph: with particular reference to railway communication with Scotland, and to Irish Railways. By William Fothergill Cooke, Esq. London: Simpkin, Marshall and Co., Stationer's-Hall-court. 1842.] 8vo., Pam., 39 pages. Plates.

1842—SAMPSON, Thomas.

[Electrolint, or the Art of making Paintings in such a manner that Copper plates and Blocks can be taken from them by means of Voltaic Electricity. By Thomas Sampson. Published by Edward Palmer, Philosophical instrument maker, No. 103 Newgate-street, London. 1842]. Pamphlet.

1842—SHAW, George.

[A Manual of Electro-Metallurgy, By George Shaw. London: R. Groombridge, Panyer alley, Newgate-street. MDCCCXLII.]

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NITRIC ACID BATTERIES.

SOME few weeks back we referred to some experiments which were being made relative to certain forms of battery in which nitric acid is used, and with the double purpose in view of dispensing with the porous vessel usually employed to contain the acid, and of obviating the consumption of this fluid by allowing of the gradual recombination of its separated constituents. Although these experiments—owing to causes which were imperfectly perceived until illustrated by actual trial—were unsuccessful so far as a practical result is concerned, they are sufficiently interesting and instructive to induce us to give a brief description and explanation of them.

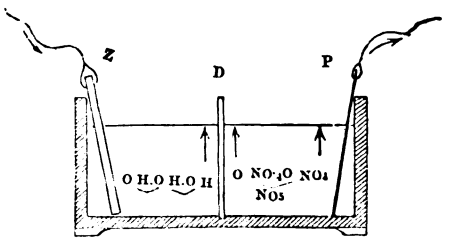
The principal reason why nitric acid proves to be so eminently adapted as an exciting fluid for the carbon or platinum negative element of a voltaic couple, is readily perceived when we compare this fluid with water, or water rendered more conducting by the addition of sulphuric acid, as an electrolyte. With the latter, while the positive element takes oxygen from the fluid, hydrogen is liberated at the surface of the negative element, say of platinum. Now, hydrogen is strongly electro-positive in relation to platinum, and, in virtue of the affinity due to this cause, becomes condensed upon the metal, rendering the latter electro-positive to platinum in its normal condition, or making it to some extent analogous to a more electro-positive metal, such as zinc. While zinc opposed to zinc, as a couple, would give no current at all, the current with zinc and a *polarised* platinum element is, for the same reason, much less powerful than that produced by zinc with platinum in its normal condition. This explains the rapid diminution of power observed in a couple formed of a plate of zinc, and one of platinum immersed in dilute sulphuric acid. If to the latter we add a few drops of nitric acid, the hydrogen upon the platinum becomes removed by oxidation; but in this case, as the proportion of nitric acid is inconsiderable, water is still the principal electrolyte, and the platinum constantly tends to become polarised. The case is different, as we latterly have had occasion to show, when the negative element is immersed in strong nitric acid. Hydrogen is not then liberated, as has been generally assumed, at the surface of the platinum, —nitric acid being far more readily electrolysed or decomposed than water. Instead of hydrogen, therefore, we have directly evolved a compound of nitrogen with oxygen—nitrous acid—which is electro-negative rather than electro-positive in its nature, and which, consequently, tends in no degree to diminish by polarisation the original electro-motive force developed in the couple.

Unfortunately, nitric acid is not only expensive in the first instance, but, in its use as an exciting fluid, nearly six-sevenths of the pure acid is wholly lost; one equivalent of oxygen merely being consumed, and the remainder, NO_4, or nitrogen with four equivalent of oxygen, being evolved in the form of the nitrous fumes which constitute such a drawback to the employment of nitric acid batteries. No effectual plan has yet been suggested for collecting and subsequently oxidising this waste product, so as to reconstitute nitric acid. The endeavours which have lately been made in this direction are based upon the following data:—

If we divide a wooden trough into two partitions by means of a division of metal (marked D in the figure), and fill it with water, or with water of which the conductivity is improved by the addition of salt or sulphuric acid, then, by passing the current from a battery through the fluid, an electrode being immersed in each partition, the fluid will become decomposed, oxygen being evolved from one surface of the partition (if of platinum or silver), and hydrogen from the other surface. Supposing the plate marked Z to be the positive electrode of a battery not shown in the figure, and the plate marked P to be the negative electrode (both of platinum, or silver), then oxygen would be evolved from Z, hydrogen from the left hand surface of D, oxygen again from the right hand surface of D, and hydrogen from P. The same action substantially takes place when D is a partition of non-conducting material, providing the two portions of fluid be connected by means of a bent wire or strip of metal.

Now the positive element of a couple is the anode or positive electrode in relation to the fluid within the cell—although a wire attached to this element constitutes always the negative pole or electrode in relation to any electrolyte that we may decompose externally. The conditions are, therefore, the same as in the preceding case when we substitute a plate of zinc (Z) for the positive electrode of a battery, and a strip of platinum (P) for the negative electrode. The zinc will take oxygen from the fluid, hydrogen will evolved from the left hand and oxygen from the right hand surfaces of the metallic division (D), and hydrogen will be evolved from the urface of the platinum element.

In the right-hand division of the trough, containing the platinum element, let us now substitute pure nitric acid for the dilute sulphuric acid, the latter fluid being still in contact with the zinc in the other partition. Everything will occur as in the preceding case, with the exception, that, instead of hydrogen, NO_4, or nitrous acid, will be evolved from the surface of the platinum element P.



The mode in which electrolytic conduction, resulting in electrolysis, is effected, is indicated by the letters in the figure. The zinc becomes oxidised by combination with oxygen, from the water; the liberated hydrogen combines with the oxygen of the succeding molecule of water (HO, or OH), and successive decompositions and recombinations occur, until the electrolytic conduction is interrupted by the partition of metal. Here the current leaves the fluid to enter the metal, the left hand surface of which constitutes, therefore, the cathode, or exit of the current from the fluid, at which point the electro-positive constituent of the fluid is invariably evolved in electrolysis. The right-hand surface of the metallic division constitutes the anode, or entrance of the current to the fluid, and consequently the electro-negative oxygen is evolved from this surface. This oxygen is liberated from the nitric acid (NO_5), leaving a molecule of nitrous acid (NO_4) which immediately decomposes the molecule of nitric acid next in succession, reproducing nitric acid; and this action is continued until, at the cathode (P), nitrous acid becomes evolved.

In will be seen that the constituents of nitric acid, $O+NO_4$, which, by recombination, reproduce NO_5, are both evolved from the right-hand division of the trough. Moreover, the oxygen is evolved in an ozonised form, in which its chemical affinites are greatly intensified. If, therefore, we hermetically close the right-hand partition, so as to prevent the escape of the gaseous products into the atmosphere, we may expect to obviate any waste or consumption of the nitric acid in which the platinum element (P) is immersed. We find, in fact, that though the nitric acid is decomposed by the passage of the current, it is reconstituted from the evolved gaseous products, and that no waste of acid therefore takes place, for whatever length of time the voltaic action may be continued.

Unfortunately, we can derive no advantage whatever from this fact. Our object in using nitric acid as an "exciting fluid" for the negative element is, as we have seen, to prevent the polarisation of this element by gaseous hydrogen. In adopting the above arrangement, we add considerably to the internal resistance of an ordinary Grove's couple; but this, though it reduces proportionately the quantity of electricity traversing a circuit of very small resistance, is of very little consequence so long as we preserve the electro-motive force or tension of the Grove battery. By using the partition of metal in the trough we have virtually two couples in series instead of one. This will be evident if we suppose the partition D to be formed of an insulating material, and a bent strip of platinum to be placed upon it, establishing a metallic connexion between the two fluids. No *increase* of electro-motive force can be obtained by this means—such as would follow from the use of a compound strip of platinum and zinc; but, providing the original conditions remained constant, we might expect to preserve the tension due to the single Grove's couple. The phenomenon of polarisation, however, soon becomes manifest in the negative element of one of the couples, viz., upon the surface of D facing the zinc plate, and which is not in contact with any oxidising agent; and this is sufficient to render nugatory the employment of nitric acid for what we may term the negative element of the second couple, viz., the platinum strip P.

The polarisation, by condensed hydrogen, of the cathode at D—an effect which might have been foreseen in a more careful consideration of the conditions involved in the experiments in question—renders ineffectual any means such as we have pointed out, for obviating the waste of nitric acid in batteries, when this substance is employed. It is evident that one of the couples in the above arrangement is a simple combination of zinc and platinum in acidulated water, and that the couple to which it is united must be completely inactive as regards electro-motive force, being composed of two platinum surfaces in contact with nitric acid. In all the experiments which

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have been tried in this direction, and in which negative elements of carbon or platinum were immersed in cast-iron, or other metallic vessels containing nitric acid, and closed from the air, the same conditions prevailed; and we must, therefore, look to other means for economising the expenditure in working with nitric acid batteries. The study of the above problem may perhaps, however, conduce to a more successful solution of the question.

Recent Patents.

1482. R. LAMING, *Priory-road, Kilburn*, "*Constructing and using electric telegraphs.*" Dated 16th May, 1862.

THE patentee claims as his invention, with respect to the electric telegraph generally, the adjustment of its parts to one another, as described; and also using either or both ends of a telegraph, with its parts so adjusted, in the way specified, or with such modifications as may embody his invention; but he does not claim the simple application of the opposite poles of two batteries at the two ends of a line, when unaccompanied with the adjustments to the wire of the voltaic elements, and of the coils of instruments, opposite poles having already been so applied, though for a different purpose. And with respect to marine electric telegraphs in particular, he claims the constructing and using of subaqueous telegraph cables, with conductors immediately surrounded by insulators of dried organic material in a fibrous condition, saturated with insulating cements. Also constructing and using subaqueous telegraph cables, in which the insulation and the tensile strength are conferred either wholly or in part by dry organic materials used in a fibrous condition. Also the application and use of tubes of caoutchouc and of lead, and of servings of vulcanised caoutchouc, and of other coverings that are sufficiently impervious to water for keeping dry insulators of subaqueous telegraph cables composed of dried hemp and insulating cements, and that depend for their efficiency upon an artificial desiccation, which perhaps they might not otherwise so perfectly maintain.

1516. T. MORRIS *and* R. WEARE, *Birmingham, and* E. H. C. MONCKTON, *Fineshade, Northampton*, "*Obtaining and applying light and heat by electricity.*" Dated 19th May, 1862.

THIS invention consists in obtaining light by passing electricity through vacuum tubes, or other suitable vessels, the electricity employed being obtained from frictional, electro-magnetic, magneto-electric, or hydro-electric machines, and also from other sources.

1540. C. W. SIEMENS, *Great George-street, Westminster*, "*Electric telegraph apparatus.*" Partly a communication. Dated 22nd May, 1862.

THIS invention consists in communicating codes of signals by particular mechanical agency, by which great rapidity and accuracy of transmission is obtained. In the specification to former letters patent granted to the present patentee, and bearing date the 25th day of February, 1859 (No. 512), he described an arrangement wherein types were employed, having elevations or depressions representing the letters or signs to be transmitted, which types were arranged in a row, or in rows, and acted consecutively upon a contact lever in connection with a galvanic battery, or other source of constant currents of electricity, so as to cause it to make and break contact with the recording instrument, thereby producing signs exactly corresponding with the form of the types. In the present invention the arbitrary succession of signals constituting a letter, number, or sign, is represented by a type or by types, which is or are so formed that, on being passed along against a contact lever, a series of currents is passed through the line wire, which currents are produced by a magneto-electric machine or other apparatus that produces a regular succession of currents, the same being moved in such a manner by the same mechanism which imparts motion to the types that, at the moment when the types complete the line wire circuit, a positive or negative current, such as may be required, is produced and transmitted through the line wire.—*Not proceeded with.*

1549. G. BARLOW, *Birmingham*, "*Laying submarine telegraph cables.*" A communication. Dated 22nd May, 1862.

THIS invention consists in laying submarine telegraphic cables by partially supporting them below the surface of the water during the paying out of the same by means of friction clutches or appliances supported from the ship's side.—*Not proceeded with.*

1550. H. COOK, *Manchester*, "*Electric batteries.*" A communication. Dated 22nd May, 1862.

THIS invention has for its object the construction of a battery which shall work during several months without it being necessary to interfere with it, or renew any of the chemical agents which are employed to develop currents of electricity. The invention relates to a modification of that description of battery known as the Daniell's battery, and consists in the employment of sand, or any other pulverulent substances unattackable by acids, in place of the porous vessel ordinarily used. In combination with this sand or other substance sulphate of copper in the state of powder is employed in sufficient quantity to last several months.

1496. C. BINKS, *Parliament Street, Westminster*, "*Obtaining oxygen and chlorine gases.*" Dated 7th May, 1862.

THIS invention consists, first, in causing, by any convenient means or kinds of apparatus or appliances, a mixture of hydrochloric acid gas and oxygen gas, or a mixture of hydrochloric acid gas and atmospheric air, or atmospheric air mixed with a larger proportion of oxygen gas than the proportion contained in atmospheric air in its natural condition, to be brought in contact with concentrated or strong sulphuric acid, either under ordinary temperatures, or under temperatures higher than ordinary ones, in order to effect the decomposition of the hydrochloric acid with the liberation of its chlorine in the form of gas. The invention consists, secondly, in projecting into, or otherwise bringing in contact with, liquid hydrochloric acid (by means of any convenient apparatus or appliances) strongly heated oxygen gas or atmospheric air, or a mixture thereof, in order to effect the decomposition of the acid, and liberation from it of gaseous chlorine. Thirdly, the invention consists in certain improved methods of effecting the well-known reactions between gaseous hydrochloric acid and oxygen gas, when these reactions are applied in the production of chlorine. Fourthly, the object of the invention is to facilitate and economise the production of oxygen gas; and it consists, first, in projecting into, or otherwise bringing into contact with, water (by means of any suitable apparatus or contrivances) chlorine gas so strongly heated as to effect on such contact the decomposition of the water, the result of a combination between its hydrogen and the chlorine forming hydrochloric acid, which is retained by the excess of water present, and thus liberating its oxygen in the form of gas.—*Not proceeded with.*

1541. J. H. PERRY, *Piccadilly, London*, "*Curing diseases of the human body by magnetism.*" Dated 22nd May, 1862.

THIS invention consists of an apparatus, which the patentee denominates the magnetic equilibust, or regulator of the human health. The apparatus is formed of suitable design and dimensions, with movable and adjusting parts, capable of receiving and supporting the human body in a sitting or reclining position, and the part which receives and supports the head is fitted with a magnetic cap, or other vestment, in which polarised magnets are arranged, as hereinafter described. The arm rests are fitted with one or two galvanic batteries, and to the part which supports the back of the patient a belt, in which a number of polarised magnets are also arranged, is fitted. This belt is intended to pass round the body or loins, and is provided at the ends with suitable fastenings for securing it in the required position. At the seat of the frame a cushion, in which a galvanic battery is fitted, is also placed, and upon the part which supports the feet another galvanic battery is mounted. The batteries for the feet and seat are square, and those for the hand are semi-cylindrical, and are formed with or adapted to square, cylindrical, or semi-cylindrical metallic chambers, furnished with heaters, to be used as circumstances may require. The square battery for the feet is fixed to a semi-cylindrical metallic chamber, and mounted upon an axle, so as to be capable of being moved by the foot. The parts of the semi-cylindrical batteries, upon which the hands rest, are also mounted upon pivots, or universal joints, so as to afford free movement to the hands. The seat battery is also mounted upon an axle or dead pin, to allow the necessary movement thereof. By means of the magnetic vestments and galvanic batteries, a permanent though insensible magnetic current is established throughout the body, from the head to the feet, without having recourse to any additional conductor than the polarised magnets, the galvanic batteries, and the vital principle of animal life. Small batteries, to be used without heat, are also placed in the soles of the shoes or boots.

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THE INTERNATIONAL TELEGRAPH COMPANY.

THE following letter has appeared in the *Daily Telegraph* :—

SIR,—The willingness with which you seem ever ready to espouse the cause of the weak, and to expose the unjust doings of the powerful, induces me to lay before you the gross injustice—or at least what looks extremely like injustice—which is being practised by the above company upon a class which is very incapable of protecting itself from the wrongs inflicted upon it. This company, for economy's sake no doubt, employs a large number of young females at their office in Lothbury. Those young persons are taken on trial before they are permanently appointed, but will it be credited, that the period of trial or probation, instead of being confined to three or four weeks—which ought to be amply sufficient to test the capabilities of any girl—is extended to five or six months, and that during all this time those girls receive not a single farthing from the company for their five or six month's labour? Now if this be not injustice, I do not know what the word means. And when you come to consider the paltry wages—8s. a week—which those females receive even when appointed permanently, it is indeed wonderful how their friends allow them to go week after week in wet, and mud, and cold, to toil for nothing for this company. But I suppose they are induced to do so hoping every week that next week, at all events, their dear girls will be remunerated for their labour. Had you, Sir, seen, as I have, a poor mother strip herself almost to nudity to enable her daughter to make a suitable appearance at the telegraph office—for those girls must dress neatly also—and then witnessed the terrible disappointment which was stamped on her countenance as week after week—nay, month after month—passed on, without this daughter being able to show any return for this outlay, you would not hesitate for a moment to denounce this monstrous injustice on the part of the Electric Telegraph Company. If you will give this communication a corner in your valuable paper, you will, I am sure, receive the hearty thanks of many a poor mother.—I am, Sir, yours &c., E. D.

January, 3, 1863.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Fine Para	2s. 1d. to 2s. 2d.	per lb.
Negro	1s. 1d. to 1s. 3d.	„
Java	1s. 5d. to 1s. 6d.	„

GUTTA PERCHA.

Fine	2s. 6d.	per lb.
Genuine Mixed	1s. 9d. to 2s. 0d.	„
Ordinary Reboiled	1s. 0d.	„

Both articles are very firm in price, and likely to be much higher.

January 7, 1863. WM. KIRKMANN,

4, Howford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	62 to 66	———
20	Do. B 7 per cent. till 1862	—	———	———
Stock	Electric Telegraph	100	98 to 100	———
25	Do. New	—	———	———
—	London District Telegraph	4¾	4 to 3 dis.	———
—	London & S. of Ireland Direct.	—	———	———
—	Mediterranean Extension Tel.	all	3½ to 4½	———
10	Do. 8 per cent. pref.	all	———	———
1	Submarine Telegraph, scrip.	all	⅜ to ⅝	———
1	Do. registered	all	⅜ to ⅝	———
10	Do. „	all	4 to 6	———
2	Telegraph to India	1	⅝ to ¾ dis.	———
5	United Kingdom Telegraph	3	¼ dis. to ¼ pm.	———

ON THE FORMATION OF ACETYLIDE OF COPPER IN COPPER TUBES FOR CONVEYING LIGHTING GAS.

BY M. CROVA.

IT is well known that copper tubes, long used to conduct lighting gas, have sometimes, during the cleansing of the interior, occasioned very dangerous and sudden explosions, occasionally proving fatal to the workmen. In one of the scientific reviews, an accident of this kind is recorded as happening at Philadelphia.

Acetylide of copper having the property of detonating by an elevation of the temperature or by a blow, and the presence of acetylene in lighting gas having been recently proved by M. Berthelot, I have tried to ascertain whether acetylene, in presence of air, could combine with copper, and so form acetylide of copper.

By passing a mixture of air and moist acetylene through a glass tube containing bright copper turnings, this metal tarnishes rapidly, assumes iridescent colours, and finally becomes black; but as this alteration takes place only on the surface of the metal, it is very limited.

By using copper reduced by hydrogen, I extended the surface of the metal. A small quantity of metal was placed in two flasks containing a mixture of equal volumes of air and acetylene, and also in one of the flasks a drop of ammonia. The two flasks, well stoppered, their necks plunged in water, were left to themselves for two days. They were then carefully opened, and the water entering them absorbed nearly half the gaseous volume. The absorption seemed to be somewhat greater in the flask containing a little ammoniacal vapour. The copper turned black. After washing and drying, I found that it contained a notable quantity of acetylide of copper; for, heated with hydrochloric acid, it disengaged acetylene, and, thrown on a heated metallic plate, a louder explosion resulted than with pure acetylide, and without deposit of carbon. This difference will be readily understood, for the acetylide formed during my experiments, finding itself in presence of excess of iodide of copper, the carbon and hydrogen of the acetylide were entirely destroyed.

It is evident that copper, in presence of air and acetylene, is spontaneously transformed into acetylide of copper containing excess of iodide. As lighting gas contains acetylene, a little air, and perhaps even some ammoniacal vapours, it is obvious that acetylide of copper may be formed in tubes which have served to conduct lighting gas.—*Comptes Rendus.*

PRELIMINARY NOTICE OF THE ORGANIC AND INORGANIC OBJECTS OBTAINED FROM THE SOUNDINGS OF H.M.S. "PORCUPINE," OFF THE WEST COAST OF IRELAND.

By Professor William King, Queen's College, Galway, and Queen's University in Ireland.

SUFFICIENT time has not elapsed to enable me to make a detailed report on the various objects which the Lords Commissioners of the Admiralty have done me the honour to place in my hands for examination. I trust, however, to have the report prepared for the press in the course of this winter. On the present occasion I purpose giving a summary of the results of my investigations as far as they have been conducted.

The greatest depth at which specimens have been obtained is 1,750 fathoms. The soundings from this and less depths—up to 500 or 600 fathoms—consist essentially of the same kinds of microscopic organisms already made known by Bailley, Wallich, and others.

The marvellous profusion of *Foraminifera* and other minute structures occurring on the Atlantic sea-bed wherever it descends below the level of a few hundred fathoms, shows that over a vast portion of the submarine area between Ireland and the United States, there are being formed calcareous deposits analogous to common limestones. While nearly all the particles of these deposits are either testaceous coverings of dead *Foraminifera* or the impalpable debris of their shells, it is evident that the surface of the Atlantic sea-bed is one vast sheet of the same organisms in a living state, whose office it is to clear the waters of the ocean of all the mineral and organic impurities which are ever flowing into them.

Much of the deep sea "ooze" procured during the survey bears a striking resemblance to the roe of a fish, owing to its containing an immense profusion of *Globigerinæ*. This circumstance led me to suspect that roe-stone or oolitic limestone, instead of being, as is generally conceived, a concretionary deposit, is a purely foraminiferous formation. In prosecuting my investigations on this point, although I have failed to detect any well defined specimens of *Globigerinæ* in oolite, I have been rewarded by discovering that it consists essentially of an allied monothalamous *Foraminifera*. Having carefully examined type specimens of Carboniferous, Permian, and Jurassaic oolitic limestones, respectively from Bendarry in Kildare, Sunderland in Durham, and the Isle of Portland, I have no hesitation in stating that they consist for the most part of an organism identical with, or allied to, *Orbulina universa*.

Although perforating mollusks are living at great depths, I do not think that there are any grounds for apprehending that they would bore into a telegraph cable. I am also inclined to believe that there is little chance of a cable getting injured if laid down on foraminiferous bottoms; as in such places vital and chemical actions appear to be going on so unceasingly and copiously that a cable thus circumstanced could not but become covered up in the course of a few years with considerable foraminiferous accumulation.

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The survey has been fortunate in bringing to light some other interesting facts in microscopic life. It has also made known some species of shells and other animals new to the British Fauna, besides extending our knowledge of the habitats of certain rare species.

Rising out of a deep seated area of *Globigerinous* deposits, and at the distance of 120 miles West of Slyne Head in the county Galway, occurs a bank which has been named the Porcupine Bank, consisting of siliceous sand and coarse gravel, the latter chiefly composed of sub-angular pieces of granular quartzite (? metamorphic), granite, chloritic quartz, &c.; along with which occur considerable quantities of the debris of *Nullipores*, shells, and other organisms. The larger pieces, some of which are three or four inches in diameter, have often attached to them fresh specimens of *Rotalia* and various genera of *Bryozoa*; occasionally they bear specimens of *Crania Norvegica*. A number of fishes was procured by the dredge on this bank in about eighty fathoms water. One a species of *Psetta*, allied to the "whiff"; another a species of *Sebastes*, allied to the Norwegian haddock: both appear to be unrecorded as British species.* There were also brought up by the dredge from the depth of a hundred fathoms *Pilidium fulvum*, *Limatula subauriculata*, *Scimurella crispata*, *Leda pygmaeæ*, *Arca raridentata*, and other scarce shells; besides sponges, star-fishes, sea-urchins, &c. The same prolific bank yielded an abundance of a large hermit crab, specimens of which were tenanting one of the rarest British shells, *Buccinum ovum*.

There also came up in the dredge a specimen of *Litorina litorea*, which though insignificant in itself, may prove of considerable importance. The specimen is an adult one, and, though broken, has a fresh appearance, and retains interiorly its characteristic *nacre*. How has this shell, which only lives between ordinary tide-marks, and feeds on the *Fucus* peculiar to this tract, got into eighty or ninety fathoms water, and at the distance of 120 miles from the shore? It may have been swallowed by a cod or some other fish and carried thither; it may have got entangled in the roots of a seaweed, which afterwards floated out into deep water; it may have been transported to the spot where it was dredged by a strong current setting off from the land. The great accumulation of coarse gravel and pebbles on the bottom from which this shell was taken is a remarkable fact.

At the depth of 340 fathoms, the sounding machine brought up *Globigerinous* mud containing dead specimens of a *Pecten*, an *Arca* and a *Petunculus*, which appear to be new; also specimens of *Trochus milligranus* in the same condition. A perfectly fresh specimen of a new *Cochloderma* was also brought up from the depth of a thousand fathoms, and at the distance of a hundred miles west of Cape Clear. This is perhaps the greatest depth at which a bivalve, evidently living there, has been obtained.

Too much credit cannot be awarded to Mr. Hoskyn and the officers of the *Porcupine* for the zeal which they displayed in collecting and preserving the various objects I have noticed. Their labours, it is well known were frequently conducted under the most adverse circumstances, and during a singular succession of unfavourable weather. Nevertheless, the results of the survey, both as regards Natural History and Geology, are highly valuable.

TEMPERING STEEL BARS FOR MAGNETS.

THE following valuable suggestion were published many years since, by Mr. W. Walker, Master, R.N.:—As magnetism is now applied to many purposes of practical utility, as well as in many instructive and amusing experiments, and as artificial magnets can easily be made of greater power than loadstones, I presume it will be acceptable to many of your readers to know how artificial magnets may be made without any risk of failure.

Makers of magnets and compass-needles know that if the most careful and skilful workman be employed in preparing a number of magnets from the same steel bar, the magnetic power of the magnets, when compared with each other, will greatly vary; although every possible care may be taken in forging, tempering, and magnetising, in an uniform way. Experience in these matters convinced me that discrepancies in the magnetic powers of magnets of the same length, weight, and quality of steel, arise from the *tempering alone;* for if the metal be heated in a furnace, or coal fire, one part of the bar may be in contact with glowing coal, another part in flame, a third in heated air, a fourth in contact with coal in a state of ignition, &c.; consequently, the metal is not in all its parts raised, to the *same* temperature, when suddenly removed from the fire and plunged into a cooling fluid. The relation between the degrees of heat in the heating and cooling mediums is absolutely unknown; magnets tempered in this uncertain way will possess different degrees of hardness throughout their length, and their capacity for magnetism in all their particles will be unequal and uncertain.

Reasoning in this way, it appeared to me, that in order to make compass-needles and steel magnets successfully, we require *specific heats* in the *warming* as well as in the *cooling* process of tempering, in order to ensure the same degree of hardness throughout the steel bars: that is to say, that the metal when cold should be a homogeneous mass, and possess a uniform capacity for the reception and retension of the magnetic virtue.

Metallurgists know that lead melts at a low temperature, but if left on a good fire, it gets first a red, and then a white heat: that continuing to absorb caloric, it ultimately *boils* at a uniform heat, which melts gold or silver, as is evident in the process of "cupelation." Now, here we have a *specific* heat at probably 5,000°, and we have also a specific heat of boiling water at 212°. It therefore struck me, that by heating my needles in boiling lead, and cooling them in boiling water, every particle of the steel would be first raised *to*, and then cooled down to the same temperature and degree of hardness. The experiments have been made with complete success; and more powerful magnets have been made in this way than were ever made before, *without risk of failure.*

Magnets weighing 600 grains, and 6 inches in length, have held in suspension 14 times their own weight; and compass-needles have given by deflection 30°, at twice their length from a test-needle. I find that magnets tempered in this way are not liable to break, but possess with great hardness a *toughness*, derived probably from the boiling water. Their power of retaining the magnetic energy has *for four years* remained unimpaired, although left without "keepers."

To manufacturers of magnets and makers of compass-needles, a knowledge of this mode of tempering steel, at a specific temperature of the heating and cooling mediums, will enable them to make articles of a superior quality without risk of failure, or needless expense; and as I have no other object in view than the advancement of useful knowledge, I now send you these remarks for publication.

In heating the steel, the bars require to be pressed under the surface of the boiling lead (as the steel would otherwise float on its surface), and the magnet should be suddenly shifted from the lead to the boiling water, the instant it has acquired the temperature of the boiling lead; for to leave it longer in the lead would spoil the smooth surface of the steel, and render it as rough as if heated in a furnace or common fire.

INTERNATIONAL EXHIBITION, 1862.

THE MARINER'S COMPASS.—The jury observed with satisfaction the progress generally made in the construction of this invaluable instrument. Excellence and fidelity of workmanship, combined with a minute attention to details, are prevailing features of the exhibited specimens. This is progress in the right direction, for with the increasing use of iron in shipbuilding and fittings, an efficient compass is imperative, and thorough efficiency cannot be secured without the same care in details and delicacy of manipulation as is bestowed on the sextant or chronometer: such was not the compass of a past generation; but it was not an "iron age."

In connection with the mariner's compass, the subject of the magnetism of iron ships is one of such importance at the present time, that the jury are tempted to digress, perhaps, from their legitimate path, to review briefly the past and present state of this branch of science as affected by the great changes in naval architecture. In 1851 the laws and general principles affecting the compass in iron ships were professionally unknown. They had seriously engaged the attention of a few leading men of science, and so far back as 1839, the present Astronomer Royal of England had made an extended series of experiments, by the desire of the Lords Commissioners of the Admiralty, in the iron merchant ship *Rainbow*. The resulting abstruse investigations did not receive then the attention they merited, though a tentative mode of adjusting the compass, published in 1840 by Mr. Airy, became the basis of a system of compensation since generally adopted in the mercantile marine.

The rapid increase of iron-built ships subsequent to 1851, and the consequent appreciation of compass disturbances, produced numerous plans; some for detecting the deviations without the aid of astronomical or other well known observations, others for correcting the deviations by peculiar arrangements of magnets, and even appliances for isolating the compass from the effects of local attraction appeared; many of these plans, resulting from an imperfect knowledge of the laws and mode of action of magnetism, were undoubted failures.

The melancholy loss of the iron emigrant ship *Taylour*, with a great number of the crew and passengers, on the east coast of Ireland, in the early part of 1854, was traced in the main, on the official inquiry, to the changes of the ship's magnetism, or the imperfect action of the compasses, which had been compensated at Liverpool a few days previously to the ship sailing from that port. Public opinion, which was much divided on the subject, eventually invoked the aid of science. A special discussion took place at the British Association at Liverpool in 1854, and ultimately a committee composed of practical and scientific men, interested in the

* Specimens of a pipe fish were captured on the surface of the Atlantic, 200 miles West of Galway. It appears to be a species undescribed as British.

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question, was formed at Liverpool for the purpose of collecting information and making the necessary experiments. Three reports of this committee, the last dated February 1861, have been presented to the Board of Trade, this department of Government having liberally assisted the enquiry throughout. To this source, and to the investigations of the Astronomer Royal and Archibald Smith, Esq., F.R.S.— with the researches in the same field by other well-known names, among whom we may worthily select the President of the Royal Society, General Sabine—the jury have every confidence that a secure foundation of the theory and practice of compass management in iron ships is laid, which alone requires the general spread of education to render familiar to the intelligent seaman.

The recent improvements in the mariner's compass may be considered under three heads :— 1. Independently of the deviation of the compass caused by the local attraction of the ship. 2. As regards arrangements for the correction of the deviation. 3. As regards arrangements of the compass for the purpose of diminishing, but not for the purpose of correcting, the deviation of the compass.

1.—The principal modern improvements have been the introduction of compound needles, and in the manufacture and fitting liquid compasses—the use of the latter, in any excessive motion of a ship or boat, being almost indispensable. Sir W. Snow Harris has also introduced a very effective compass, in which the oscillations are much reduced by the application of a thick copper ring in the compass bowl, and allowing the poles of the needles to approach very near to it.

By substituting two or more parallel bars for a single bar, which was formerly in universal use, several advantages are obtained; for example, the bars may be placed on their edge, whereby there can be no alteration of their magnetic axes. Greater directive power is obtained with the same weight. Also a combination of two equal parallel bars, of which the ends are 60°, or four of which the ends are 30° apart, have the moments of inertia about all horizontal axes equal, and oscillations of the card about any axes are performed without any wabbling motion.

The following remarkable property also exists :—When magnets or soft iron are placed as correctors, unless the needle be very short compared to the distance of the disturbing magnets or iron, a deviation is introduced depending on the length of a needle. This disappears if instead of the single-bar needle the compass is composed of two bars, of which the effective ends are 60° apart. The same is the case with the needles, arranged as in the common Admiralty compass, viz., at 15° and 45° on each side of the diameter. Such compasses are therefore much better adapted for being corrected than single bar needles.

2.—Since the attention of the public has been turned to the subject of the deviation of the compass, many schemes have been suggested, and many patents taken out for obviating entirely the effect of the iron of the ship on the compass, the projectors overlooking the fundamental law of magnetism that the interposition of a body between the magnet and the needle on which it acts can as little intercept the action of the magnet as the interposition of a body between the earth and another body would intercept the action of the gravitation of the earth ; and also overlooking a very obvious consideration, that if any body could intercept the action of the ship's iron, it would also intercept the action of the earth's magnetic force on the needle.

As such inventions can rarely be embodied in a model without opening the eyes of the inventors, it is, perhaps, not surprising that of the many inventions which have been proposed for this purpose not one has been sent to the Exhibition.

The mode of correction by magnets and soft iron is susceptible of so many modifications, that a greater number of appliances for this purpose than have been sent might have been anticipated. Two only are exhibited. One, the model of a binnacle or steering compass, designed originally for the main deck of the *Warrior*, and ships of her class, is exhibited by the Lords Commissioners of the Admiralty. The arrangement thus introduced is remarkable both in itself and also historically. It was many years ago observed that two compasses placed near each other, as in the common double binnacle, would produce a mutual disturbance. A regulation about the time was issued by the Admiralty, forbidding the placing such compasses within such a distance as to allow of the effect being perceptible.

To be concluded in our next.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—On Saturday, the 20th inst., about 5 p.m., the roof of the Parkhill Station, on the Formartine and Buchan Railway, was torn off by a gale of wind, and the telegraph wires, which were about two feet above the roof, carried away with it, and broken in several places. There are three wires on this line, it being fitted up with an ordinary D. N. circuit, and a train signal circuit (Tyer's instruments being used). The ends of the wires of the D. N. circuit found dead earth south of station, and only partial earth north of station. The ends of signal circuit wire was also on the ground, but not in contact with the D. N. wires.

Now comes the query, there was about 150 yards of the signal circuit wire coiled up in several pieces, and lying down the embankment, or over in the adjoining field, it being broken in three places. Still the trains on Saturday night were correctly signalled twixt Wyce junction and New-Machar, and *vice-versa*, a distance of five miles, and also on Monday morning, before the wires were put to rights, the only difference visible being, the signals scarcely so strong as usual, but of sufficient strength to take over the needles, also to ring the bell and gong.

Can you, or any of your readers, give any information, as to how the current passed through the 150 yards, where the wire was wanting, the wires of the D. N. circuit were broken and lying over in the field, the same as the signal circuit wire.

The question having been sent to me for a solution, and being unable to give one, perhaps you will be kind enough to give it a place in your paper, and oblige, yours &c, E. S.

Bauchory, 31st *December* 1862.

P S. A sketch of the wires, as they were found on the Monday morning, will be sent if necessary.

To the Editor of THE ELECTRICIAN.

SIR,—Would you be so kind as to inform me, whether the statement that, a Leyden jar contains so many square feet of coating, say ten feet, is to be understood as including both the inner and outer coating, or one only ; and if the latter be the case, whether the coating ought properly to be measured on the inside or outside? I have seen somewhere in books, that both coatings have occasionally been measured, but writers in general, have forgotten to define this point.

What has become of the Electrical Society, which, according to an advertisement which appeared in your journal, was about to be formed. —I am, Sir, yours obediently. TYRO.

12th *December*, 1862.

TRAIN SIGNALLING.

To the Editor of THE ELECTRICIAN.

SIR,—I notice in your impression of the 26th. inst. a communication from Mr. F. Rudall, explaining the telegraph system of train signalling in use, on the London Chatham and Dover Railway.

The author of this letter is, undoubtedly, entitled to the thanks of your readers, for the frank and generous manner, in which he has laid before them a description of the instrument employed; but I cannot agree with him in pronouncing such a system simple and efficient; cheap it may be, efficient it certainly is not. The former without the latter will only lead to unlimited expense.

As I understand the question, the primary object of a railway signalling telegraph is to secure, as far as possible, freedom from collision, and, I think the course usually pursued, is to divide the line into certain lengths, and working the lengths by telegraph, so that no two trains are allowed upon the same length at the same time, that that which has been signalled *in* from the near end, shall be signalled *out* by the distant end, before another train is admitted. This is, I think, the correct principle of railway signalling. I cannot, however, see that any such course is followed by Mr. Rudall's arrangements. He simply signals the starting of trains to the next station. In some cases this is repeated, in others it is not apparently deemed necessary. Although the starting of each train is duly signalled to the next station in advance ; yet it does not appear that any signal is returned, advising the due arrival of the train. Here there ends allsecurity to the traveller. The instrument may be adapted to signalling trains but it cannot be said to secure freedom from accident, and therein alone lies the efficiency of a telegraphic apparatus used for signalling trains.

The subject of railway telegraphy, was very ably treated in your journal sometime back, by Mr. W. H. Preece. Referring your correspondent to this paper, (page 195) he will there find the following conditions quoted as necessary in the establishment of a railway telegraph.

"1st. The machinery employed must be of the most simple and evident description, not liable to disarrangement ; and easily repaired.

"2nd. The signals must be simple and few, and so distinctive that no mistake can occur.

"3rd. No dependence must be necessarily placed on the memory of the person in charge, and the signals should be permanent, and not temporary, or liable to misconstruction or neglect from the absence of the attendant.

"Lastly. And, more particularly, no accident should be actually caused by the derangement of the apparatus, or the absence of the signalman, but such absence or derangement should merely cause the delay of a train."

I cannot find that Mr. Rudall's instrument meets these requirements in any but the first case. The machinery he employs is simple enough ; but the signals cannot be pronounced "simple and few," or "so distinctive that no mistake can occur." He limits his signals to *ten*. *Every dependence* is placed upon the memory of the person in charge. The signals are not permanent but temporary, and in the absence of the operator a stopping ; or goods train may be signalled on any length, without anyone becoming acquainted with it (no acknowledgment being necessary to a

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signal announcing the departure of such a train). The consequences are too evident to require comment. Lastly, the fracture of the wire or derangement of the instrument, may be attended with the most unhappy results; the operator having no indicator to show that his signal has been duly transmitted. A, may signal a stopping train has started to B, the line being broken down; B, receives no signal, and s under the impression no train has been signalled. The line at B may be blocked, trains shunting &c. A, however, relies upon his signal having been duly received by B, and the train proceeds, followed undoubtedly by a collision.

Thus, the only claim, if any, Mr. Rudall's instrument has upon our attention is its simplicity of construction and cheapness. The arrangement is extremely simple, consisting of a pair of coils, armature and bell, nothing can be more so. Such an arrangement is little liable to failure. It is also cheap; but cheapness should be the very last question considered in matters where efficiency is required, such efficiency as will protect the lives of passengers. An inefficient system is always the most expensive in the end, witness the Clayton Tunnel; where, through the imperfect system then in use, the company became losers to about £30,000, finally having to introduce a more improved mode of signalling.

The most perfect, simple, and efficient system, I have seen in use is, that of Mr. W. H. Preece, where he assimilates the telegraph signals to the out-door, or line signals, in such a manner as to incorporate the two. It must be admitted that when a line has been worked by a set of signals for years successfully, that a telegraph embodying these same signals cannot fail to act likewise. Such appears to have been Mr. Preece's idea, worked out in a thorough and efficient manner. The signalman has nothing to learn, nothing to retain on his mind, all is evident, and distinct before his eyes, even more so than his out-door signals. A small semaphore—a counterpart of the out-door signal—of the most simple construction, intimates the state of the line. The key by which the semaphore is worked by the distant station is similar to the switch used by the signalman for regulating his out-door, or line signals. As soon as a train arrives out of one length, the signalman pulls *off* his telegraph signal precisely in the same manner as he pulls off his line signals; the line wire is thus brought into contact with the battery, and the current flows along the line, and through the coils of the semaphore instrument; the armature of which is attracted, and the semaphore arm lowered, signalling to the man at the near end that the train has passed out and the line is clear. Thus the signalman has nothing whatever upon his mind. The signal "line clear" or "line blocked" is always visible. These instruments cannot be more expensive than the bell and tapper of Mr. Rudall, and their efficiency is beyond doubt: indeed, a very simple addition to Mr. Rudall's bell would make it Mr. Preece's semaphore. The action in each case is alike. Additional wires are required, it is true, but the expense of another wire when once the poles are erected (as must be the case for a single wire) is but trifling. Moreover, an accident on the line, or to the instrument is instantly shown by the arm remaining at danger, the electric force being employed to *lower* the arm only, consequently the severing of the wires at any spot on the line, should an accident occur, would immediately raise the danger signal at both stations on either side of the train meeting with an accident, and insure the stoppage of all trains until measures were taken for the security of the traffic.

Apologising for my lengthy intrusion upon your valuable space, I remain, sir, your obedient servant. W. L.

London, Dec. 29th, 1862.

ANONYMOUS WRITING.

To the Editor of THE ELECTRICIAN.

SIR,—As I was walking leisurely along Cheapside a few days ago, I met a gentleman whom I knew to be deeply interested in the progress of electro-telegraphy, and whose services in promoting the practical development of that great science have been most justly and cheerfully acknowledged by the public at large. In fact, my friend was a well-known and successful telegraphist. I inquired of him if he had ever read the ELECTRICIAN? He replied that he had, and further, that he was a constant reader thereof; but, said he, "I do not like to see so many *anonymous* letters inserted in its pages. Why is it that the correspondents of the ELECTRICIAN do not affix their proper names to their communications?" I confess that my friend's query rather startled me at first; but when I took into consideration the present humiliating condition of intelligent men employed under our telegraph companies, I felt that my friend's query was a very proper one, and deserved the most serious consideration. Some of our companies have determined that their dependants shall not impart any information to the public press, or even communicate any scientific information to those papers deeply interested in the progress of telegraphy. The directors of our companies are unfortunately led, or rather misled, by a greedy host of scheming instrument-makers—to the detriment of those who have long and efficiently contributed to the practical development of electro-telegraphy. There are numerous instrument-makers in London, and elsewhere; but in telegraphy there is a family compact; the outside men have no chance afforded them of introducing their improved inventions or contrivances; the salaried monopolists engross all the advantages, and the directors and shareholders are too indolent to institute any inquiry as to the merit of the various contrivances placed before them, because they have in their employ the patentees of the imperfect instruments, which so materially affect the amount of their dividends.

"Why, sir," exclaimed my friend, "you are rather harsh in your expressions with regard to the instrument-makers; they complain as much as you do." "Yes," said I, "so they may; but my complaint is against those in the service of the companies. These men have no genius; they are simply *schemers;* they know nothing of electricity, but simply of wheels and pinions; yet to these men have been entrusted some of the most important electrical undertakings of the age. Oh for a Robert Stephenson in telegraphy! He was a self-made man, and those he unconsciously made have unfortunately been the cause of many telegraphic failures.—Yours truly, OMICRON.

WHY POWDER-HOUSES EXPLODE, AND HOW TO PROTECT THEM.

To the Editor of THE ELECTRICIAN.

SIR,—The probable reason why powder-mills so often explode, without any apparent cause, appears to me to be occasioned by the vast amount of carbon (charcoal), one of the principal ingredients of gunpowder; carbon being the next best conductor to the metals, and being in the magazine in large quantities, is precisely similar to any great mass of metal, highly attractive to draw towards it the lightning, in passing either from the clouds to the earth, or from the earth to the clouds, which last often takes place, and more frequently than is generally supposed. That large masses of metal do attract lightning to particular spots, the following may serve to show.

I once made overtures to a farmer, at Springfield, Ohio, United States, to supply him with lightning conductors, for his dwellings and barns. He replied that the lightning never came near his buildings, but that, for some reason or other, he noticed that in most electric storms he could stand at his door and see the lightning always strike a particular knoll or mound, about 300 yards off. I said, probably he might find a gold mine, if he were to dig; so, with a laugh, he invited me to an inspection (gold prompts quick action), remarking that the earth did not look like any in the adjoining vicinity. Upon examining it, I found the mound composed of a rich, brown oxide of iron. We got implements, and had a hole dug about two feet deep, when we came to a bed of rich magnetic iron ore. This may explain why the diversion of the electric fluid was particularly attracted to that spot. There was no other indication of metal, within a circuit of 100 miles. I have always directed my experience to meet this danger, and have been surprised at never having heard or read that the carbon in the powder was in itself an inviting cause. I think, after this remark, the conviction will come home to a great many, and explain why so many powder-mills explode, when it has been known that neither fire or light has been about the premises, or any frictional causes, and when such buildings have not been opened, or had any communication with for months. It is a very frequent remark in tropical climates, of lightning striking particular spots. In England the observation is not uncommon; even round our metropolis there are particular neighbourhoods, noted year after year, where lightning does damage. I believe parts of Norwood and Sydenham are subject to such visitations, in those years that lightning storms are prevalent; and, strange to say, it is not always the highest ground that in every case suffers most.

Now if I have unearthed an unsuspected enemy, I will, with your permission, explain how I disarm and remove the danger from electric overcharge, either in the heavens or the earth. It is simply this—I run over the various angles of the roof my "Patent Flat Wove Battery Copper Conductor," the whole of which I porcupine with steel magnetic points, one being placed at everyfive feet from each other. I then bring four connections to the earth, in good contact with the conductor (two connections may do for a small powder-house). These I trench out from the building, gradually deepening until it is some feet below the foundation. These numerous points will not admit of any accumulation of electricity, but perform a constant silent discharge in either case. If the earth is negative, it is diffused below the powder, by the conductors; if the earth is charged plus, it must pass off to the negative air and clouds, to equalise. To avoid danger from lightning is simple and certain, and within the reach of all, at a trifling cost. A lightning conductor not fixed according to the rules of science is a "thunder iron;" when the lightning comes near, it will convey it away in a fluid state, whereas the proper conductor avoids the fluid lightning, tapping the cloud, and silently, by constant discharge, disarms the most fearful thunder storm of its power to harm. My first order in this country, for a lightning conductor, was for a powder-house, belonging to the volunteers. The conductor was only elevated one foot above the earth, and, as I am informed, placed some ten inches in the ground, a very questionable mode of affixing. I protested, was refused even information as to its whereabouts; but I suppose had the building exploded from lightning, I should have come in for some blame, for what I had no control over whatever. If you think these remarks deserving a place in your valuable paper, I may trouble you with my plan of preventing beer from spoiling, and milk from souring, from electric causes; if otherwise, you can add to your waste paper basket.—Yours very truly, JAMES SPRATT,

Inventor and Patentee of Improved Lightning Conductors,
21, Middle Row, Holborn.

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TRAIN SIGNALLING.

To the Editor of THE ELECTRICIAN.

SIR,—The above subject is one of such vast and growing importance that it can hardly be too much discussed by practical telegraphists connected with the railway world. It has, within the last year, been my duty to recommend and carry out a plan of train-signalling, and, after considerable reflection, I adopted—with certain exceptions at particular spots on the line—that of the single-stroke bell, which is one of the oldest, and has stood the test of experience during some 14 or 15 years on the South Eastern Railway, under the superintendence of Mr. C. V. Walker. My bell is put forward simply as a convenient and compact form of instrument for carrying out that system with a slight alteration of detail.

"A Superintendent," whose letter appeared in your last number (61), must certainly have very little aquaintance with Mr. Tyer's signalling code, or he would have known that it embraces seven distinct signals with the bells and gongs, in addition to the movements of the red and black needles. Nor can he have paid much attention to the diagram of my bell, or he would have seen that all the signals are sent by the simple downward movement of the tapper, which puts one pole of the battery in contact with the line, and the other pole in connection with the earth.

With regard to the larger question of train signalling generally, my own conclusions are very decided. For lines on which the traffic is so great, and consequently the number of trains so frequent, as to render it desirable that the semaphore signals should be made subordinate to the electric signals—that the distance signal should in effect be transferred to the telegraph signalman's box—then I have no hesitation in saying that the single needle-block instrument, with bell attached for each line, is the simplest and most effectual for the purpose. It is in constant use on several portions of our line, as at tunnels, &c.; and, combined with a third instrument for verbal communications, it affords as perfect a security to the line as I believe it is possible to meet with under any system.

But there are some lines, and some portions of every line of railway where the number of trains is comparatively small, where the important stations are few, and minor stations, with a small working staff, the general rule. An elaborate and expensive system of train signalling, with a special staff of signalmen, is scarcely to be expected in these cases, especially when it is possible, by the adoption of a far cheaper and simpler plan, like that of the bells for instance, to meet the practical requirements of the district.

There is not, I believe, a trunk line running out of London which has not thus a more elaborate system of train signalling at certain spots, where additional precautions are considered necessary.

But whatever system be adopted—and it is no doubt possible to discover peculiar excellencies as well as comparative defects in all—of this every practical man must be convinced: viz., that too much care cannot be devoted to the selection of the signalmen themselves, and also to the immediate record in the train signalling book of every signal sent and received. I believe the inspectors of the Board of Trade lay more stress upon this point, and the addition of a speaking circuit, available at all times by the signalmen, than upon the actual plan used for signalling the trains, provided it be simple and well understood by the signalmen themselves.—I am, sir, your obedient servant, F. RUDALL.

London, January 6, 1863.

Telegraphic News.

LAYING OF THE TELEGRAPH CABLE BETWEEN CAGLIARI AND SICILY.—The *Hawthorne*, screw steamer from Cagliari, has arrived at Maretimo Island, 12 miles from Sicily, having laid the cable successfully to that port. She was ordered thence to Malta, to ship additional cable required to complete the line to Sicily, the ship having been taken out of her course by currents.

REID Brothers, of Wharf-road, City-road, have connected by telegraph (Professor Wheatstone's system) the central station of the London and Westminster Bank with the branch establishment in Southwark, and the one in St. James's. This is a step of great importance to the banking interest. The advantage of instantaneous communication from all the branch establishments to the central depôt is obvious.

ATLANTIC TELEGRAPH COMPANY.

THE applications for shares in this important undertaking are progressing most favourably, and there is every reason to hope that the anticipations of the public will be fully realised by the early submersion of a cable between the English and the American shores.

Miscellanea.

PATENT ELECTRIC BELLS.—One of the most important novelties in bell-ringing, and, at the same time, the latest introduction of scientific appliances to our dwelling-houses, is the new system of ringing bells by means of electricity. We have rung bells on one side of the Atlantic by batteries fixed on the other, but until now we have never thought of having a similar communication between our dining-rooms and our kitchens, between our drawing and bed rooms and our servants' halls. We have hitherto pertinaciously stuck to the old-fashioned system of cranks, levers, and copper wire, only occasionally economising labour by speaking-tubes. The invention, of which Messrs. Newall and Co., of Sloane-street, are the sole agents, possesses many great advantages. 1st, it is simple—a battery charged with chemicals is placed in any unappropriated corner of the house to keep company with the gas-meter; two wires are attached to the zinc and copper poles by which the electricity is generated and carried off. These two wires being brought together in any part of the house, causes one or more bells to ring. 2nd, it is inexpensive, as the cost of replenishing the chemicals of a battery large enough for twenty bells does not exceed 5s. a year. 3rd, it is universally applicable; it can be taken over any uneven wall or floor, and in any tortuous direction without affecting the results; it can be applied to the desks of railway stations, banks, or with equal facility to the tables of their managers. 4th, it is easily worked; it can be worked by the faintest pressure of a nob, by a lever, or by almost an infinite variety of methods. 5th, the wires can be coated with silk or cotton of any tint, so as to accord with the decorations of a room, or to be practically invisible upon them; it can be fixed to shutters, doors, and windows at night, and be made to give thence an alarm by, if required, ringing every bell in the house. There seems, in fact, no limit to the usefulness of these electric bells for domestic purposes. They have been already fixed in Windsor Castle, and in several other large buildings, where they have given every satisfaction, but as it may be difficult for such of our readers as feel interested in them to see them there in operation, a visit should be paid to Messrs. Newall's premises, in Sloane-street, where the full value of the invention can be seen, and any doubts about their efficacy be immediately dispelled.—*Building News.*

TUNGSTEN.—It has been stated that an alloy formed of 80 per cent. steel and 20 tungsten, possesses a degree of hardness which cannot, by any other means, be obtained in the manufacture of steel. The alloy works upon the latter with great facility, and can even cut it. Experiments in this direction have been made at Vienna, Dresden, &c., and considerable quantities of the alloy have been manufactured, Many old tin mines have been bought up with a view of extracting the tungsten ore.

ROYAL POLYTECHNIC INSTITUTION.—This institution still under the able and enterprising management of Mr. Pepper, opened for the holidays, as usual on boxing night. It seems somewhat derogatory to the Polytechnic to class it among places of entertainment; but in the highest and best sense it is a place of real entertainment—great amusement being blended with solid instruction. The new experiments introduced by Mr. Pepper in his "Strange Lecture" are of a most striking character; and the spectres in the scene of the "Haunted Man" have a wonderfully substantial appearance. They must be seen to be appreciated, and the sight will greatly puzzle the beholder to imagine how such a spectre, so real and yet so unsubstantial, can be thrown into the middle of the room. This experiment will be the most startling novelty produced at any place of entertainment this season. The other arrangements are almost equally good: some scenes of the pantomime being excellently managed, and exceedingly diverting. Mr. Pepper, we think, may calculate on another very prosperous season.

CAOUTCHOUC.—In the report of the late important English and French mission to the King of Madagascar, it is stated that the persons engaged in the expedition traversed extensive forests almost entirely composed of the *Ficus Electica*, or the Caoutchouc-tree.

To Correspondents.

G. P., Kensington—Deferred until next week.

E. S.—A sketch or diagram giving the *electrical* conditions under which the signals were received, *i.e.*, the comparative distance of the battery and signalling instrument from the point of rupture and earth contact, &c., is desirable, and, indeed, absolutely necessary for the solution of the interesting, practical question you have brought forward in your communication.

TYRO.—The expression "square feet of coating" has generally been used to signify "square feet of glass;" but, as you observe, both coatings have occasionally been measured. We should in preference employ the the term "square feet of coated glass." The names sent in for the Electrical Society are as yet too few in number to afford a favourable opportunity of founding this society; but further steps will shortly be taken in the matter.

J. COOK.—The plan you suggest—of employing couples with two elements of carbon in nitric acid, in conjunction with an ordinary Bunsen's cell—would be quite ineffective, neither increasing the power of the one cell, nor diminishing the consumption of acid in it. In the other cell, however, the *elements of nitric acid* would be evolved, and might become recombined; and this action constitutes the principle of the experiments, referred to in an article in the present number.

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The Electrician.

VOL. III. No. 63.—JANUARY 16, 1863.

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SECONDARY BATTERIES.

BUT little attention seems to have been given to the construction of secondary batteries, or to their application for experimental and practical purposes. The polarisation of a pair, or of a series of pairs, of platinum electrodes is often quoted as an instructive experiment, but the general utilization of more powerful secondary arrangements has but seldom and imperfectly been suggested. For experimental purposes, however, a number of small secondary cells, constructed with a positive electrode of lead, and a negative electrode of mercury, with a little moistened salt as the electrolyte, enables us, in most cases, to dispense with an expensive and cumbrous source of tension electricity in the form of a far greater number of primary cells. Our secondary cells last for an indefinite period, with no appreciable consumption of material beyond that in the primary battery, of two or three couples, employed to excite them; and, whether we require to charge an electrometer or to heat a platinum wire, they are equally available. Where they of course fail is when a constant current is required, without intermission, during a considerable period of time. But neither in the laboratory, nor for the electric telegraph, is such a current commonly necessary. The conversion, so to speak, of a current of low tension—that of the primary battery through the secondary cells connected by their similar poles—into one of high tension may be effected by touching a key, by means of which the former connection is broken, and the secondary cells are connected by their dissimilar poles. When, therefore, an *intermittent* current is required, the power of the battery is maintained.

In a note to the French Academy of Sciences, which will be found in the *Comptes Rendus* of that body,* M. GASTON PLANTE describes a secondary battery of "great power," *i. e.*, small resistance, constructed with plates of lead. The plates were separated by strips of canvas, and were coiled upon each other, as in Hare's "calorimotor." He employed nine couples, presenting a total surface of nine square feet, and, when used to obtain a spark, or temporary current of "quantity," connected as a series of three compound couples. These were immersed in dilute sulphuric acid. The primary battery was composed of five small Bunsen cells, united in single series, or for tension. The spark from the secondary battery, when duly excited, was equal to that from three hundred small Bunsen cells in a series of four or five. The electro-motive force of this secondary battery is stated to be fifty *per cent.* greater than that of a Bunsen battery; and its resistance appears to have been about sixty-six times less than that of a single cell of Bunsen of the size indefinitely referred to. The experiment of M. PLANTE appears more curious than useful in a scientific or practical point of view, and is chiefly interesting on the grounds of rendering evident the intense affinity for hydrogen of the peroxide of lead formed at the anode by the current from the primary battery. A plate of lead in dilute sulphuric acid must, under any circumstances, be very inefficient as a positive element; albeit, in the case in point, its affinity for oxygen was stimulated by that of the peroxide of the metal for hydrogen. In an arrangement similar to the above, but on a smaller scale, we have substituted a strip of zinc for one of the plates of lead, and with proportionately better results. If an intermittent electric light were required, there would be but little difficulty in supplying the desideratum by means of a secondary battery of this construction.

The suggestion of Professor JACOBI, relative to the use of a secondary battery of platinum plates, placed in circuit at the receiving station in submarine lines of telegraph, appears to have been, in this country at least, undeservedly neglected. This system has never, so far as we are aware, been experimentally tried in competition with the existing methods for obviating, to a certain extent, the retardation of signals in submarine lines. The care and study required to bring the necessary conditions into operation in this system, and in so proportioning the relative power of the primary and secondary batteries, as possibly to render the latter a really valuable auxiliary, should have been an incentive to endeavour in this direction, rather than the contrary. The theory of the system in question is perfectly clear and comprehensible, and Professor JACOBI has brought forward some interesting practical facts, in illustration of its value. When a signal is to be transmitted, the secondary battery at the receiving station is inactive, but should be rendered active, and sufficiently powerful, by the momentary passage of the primary current. When the primary battery is "cut out" of circuit, the reverse current from the secondary battery should neutralize the "current of discharge," which then tends to traverse the receiving instruments, and to prolong the signal. According to Professor JACOBI, the system was successfully applied to a subterranean circuit of considerable length, in the normal condition of which the signals, when transmitted with moderate rapidity, were invariably blended into each other. There appears to be ample occasion to test its value upon some of our own lines of submarine wire.

* Vol. L., p. 1142.

PURIFICATION OF THE SULPHATE OF COPPER.

THE sulphate of copper of commerce, is almost invariably contaminated with the sulphate and other salts of iron. A cheap and effectual mode of separating these and other impurities is of no small importance, since the sulphate of copper is extensively employed in the batteries used for telegraphic signalling, the efficiency of which is often seriously impaired by the precipitation of the oxide of iron, instead of pure copper, upon the negative plates. Besides being a bad conductor of electricity, and in this capacity greatly increasing the internal resistance of the cells, the oxide of iron also reduces the electro-motive force due to the different electro-chemical characters of copper and zinc. The suggestion of the following method of purification is due to Professor H. Wurst, of Washington.

A saturated solution of the copper salt is boiled with peroxide of lead, (PbO_2) a portion of which yields oxygen to the iron salts, becoming reduced to the protoxide (PbO). To precipitate the peroxide of iron, some fragments of the native carbonate of baryta or *Witherite* ($BaCO_3$ are added to the fluid. The sulphate of baryta ($BaOSo_3$) is thus formed, with evolution of carbonic acid, by reason of the reduced affinity of the iron oxide for sulphuric acid. The purified solution may then be decanted from the insoluble residues, and allowed to re-crystallize.

A process of purification, in which the necessity for boiling the fluid might be avoided, is still a desideratum, but there be little doubt it will be found, if the attention of chemists be directed to this important practical problem.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1843—WALKER, Charles, V.—

[The Electrical Magazine, Published quarterly. London: Published by Simpkin, Marshall and Co., Stationers Hall Court.—Published quarterly.]—from 1843 to October 1846. 8vo.

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1843—WALKER, Charles, V.—

[Proceedings of the London Electrical Society. During the Session 1842 and 1843. Edited by Charles V. Walker, Esq. Hon. Sec. London: Published by Simpkin Marshall and Co., Stationers Hall Court. 1843]—Large 8vo., 562 pages. Cuts.

1843—HARRIS, Sir W. Snow.—

[On the Nature of Thunderstorms, and on the means of protecting Buildings and Shipping against the destructive effects of Lightning. By W. Snow Harris, F.R.S.—London: John W. Parker, West Strand, MDCCCXLIII]—8vo. 226 pages. Cuts.

1843—SMEE, Alfred.—

[Elements of electro-metallurgy. By Alfred Smee F.R.S. Surgeon to the Bank of England &c. Second Edition, revised, corrected, considerably enlarged, illustrated with electrotypes and numerous woodcuts.—London: E. Palmer, 103 Newgate Street; Longman Brown, Green, and Longmans, Paternoster Row. 1843.—8vo. 327 pages, Woodcuts.

1843—STURGEON, William.—

[A course of Twelve Elementary Lectures on Galvanism. Illustrated with upwards of 100 Engravings of experiments and apparatus. By William Sturgeon, Lecturer to the Manchester Institute of Natural and Experimental Science. London: Published by Sherwood Gilbert and Piper, sold also by Charles Gilpin, 5 Bishopgate Street Without. MDCCCLXIII.] Small 8vo.

1843—FINLAISON, John.—

[An account of some remarkable applications of the Electric fluid to the useful arts. By Alexander Bain, with a vindication of his claim to be the first inventor of the Electro-magnetic Printing Telegraph, and also of the Electro-magnetic Clock. By John Finlaison Esq. Actuary of the National Debt Office, and Government calculator. London: Chapman and Hall 186 Strand, 1843.] 8vo. 127 pages. Plates.

A great number of dates are given in this work, relative to patents, and letters relating to priority of invention, &c.

1843—SOCIETY FOR THE DIFFUSION OF USEFUL KNOWLEDGE.—

[Companion to the Almanac, or "Year Book of General Information for 1843. London: Charles Knight and Co. 22 Ludgate Street.] 10mo. price 2s. 6d.

Contains an article on "Recent applications of Electricity to the Arts."

1843—DANIELL, J. Frederick.—

[An introduction to the study of Chemical Philosophy, being a preparatory view of the forces which concur to the Production of Chemical Phenomena. By J. Frederick Daniell, Foreign Sec. R.S: Professor of Chemistry in King's College London, &c.—The second Edition revised and enlarged, London: John W. Parker, West Strand. MDCCCXLIII.] 8vo. 695 pages. Cuts.

Contains, pages 228 to 293 on Electricity, 293 to 306 Magnetism, 462 to 554 on Current Affinity, Voltaic Electricity &c., 554 to 560 Thermo Electricity, 560 to 594 Electro-magnetism and Magnetic Electricity &c. 595 to 602 Animal Electricity.

This work was formerly the "text book" on Chemical Philosophy at King's College. The whole work is written without any reference to illustrations or diagrams; the whole of the woodcuts being referred to only in the foot notes. It is remarkable, therefore, for the talent displayed in dealing with such abstruse subjects as electricity, and electrical experiments without a single reference to figure of any kind. It is also valuable as containing the full remarks on the battery invented by the author, and which has been so extensively used in telegraphy.

1844—LARDNER and WALKER.—

A Manual of Electricity, Magnetism, and Meteorology. By Dionysius Lardner, D.C.L., F.R.S., and Charles V. Walker, F.R S. In 2 volumes. London: printed for Longman, Brown, Green and Longmans, Paternoster Row]—2 vols, 560 pages, illustrated.

1844—NOAD, Henry M.—

[Lectures on Electricity, comprising Galvanism, Magnetisml Electro-Magnetism, Magneto and Thermo-electricity. By Henry M. Noad, author of "Lectures on Chemistry," &c. A new and greatly enlarged edition illustrated by nearly three hundred wood cuts. London: George Knight and Sons, Foster Lane, 1844].—8vo., 446 pages, cuts.

The first edition was published in 1839, small 8vo size. There is a second part published in 1857.

1844—FARADAY, Michael.—

[Experimental Researches in Electricity. By Michace Faraday D.C.L., F.R.S., &c. Reprinted from thr Philosophical transactions of 1838-1843, with othe, Electrical papers from the Quarterly Journal of Science and Philosophical Magazine. Vol. II. London: Richard and Edward Taylor, Printers and publishers to the University of London, Red Lion Court, Fleet Street, 1844.]—8vo., plates.

1844—SCORESBY, Rev. William.—

[Magnetical Investigations. By the Rev. William Scoresby D.D., Fellow of the Royal Societies of London and Edinburgh, &c., &c. Vol. I. With illustrations. London: Longman, Brown, Green and Longmans, Paternoster Row. MDCCCXLIV.]—8vo., 364 pages. Plates.

There is another volume published in 1852.

1845—PESCHEL, C. F. Translated by WEST, E.—

[Elements of Physics. By C. F. Peschel, Principal of the Royal Military College, at Dresden, &c. Translated from the German, with notes. By E. West. Illustrated with diagrams and woodcuts. London: Printed for Longman, Brown, Green, and Longmans, Paternoster Row, 1845.]—12mo., 3 vols.

Vol. iii., part ii., section iv., contains, "Electricity," "Electro-Magnetism," and "Magneto-Electricity."

1846—BAIN.—

[Bain's Opposition to the Electric Telegraph Company's Bill.]

1847—BRETT and LITTLE.—

[Compendium of the Improvements effected in Electric Telegraphs. By Messrs. Brett and Little, with a description of their patent Electro-Telegraphic Converser, and the opinions of the public press upon its merits. London: W. J. Adams, 59. Fleet Street, 1847. Sold at the principal Railway Stations.]—Pam., Illustrated.

1847—MULLER, J.—

[Principles of Physics and Meteorology. By J. Muller, Professor of Physics at the University of Friburg. Illustrated. London: Hippolyte Bailliere, Publisher, 219, Regent Street.]

Part ii., page 327, "Of Electricity and Electrical Actions."

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1847—PROGRESS, Peter.—

[The Electric Telegraph, comprising a brief History of former modes of Telegraphic Communication, an account of the Electric Clock, Brett and Little's, Electric Telegraphic Converser, Bain's Printing Telegraph, &c., with illustrative anecdotes and engravings. By Peter Progress, Author of the "Rail, its origin and progress." London: R. Yorke, Clarke and Co., Successor to Harvey and Darton, Gracechurch Street, 1847.]

1847—VAIL, Alfred.—

[The American Electro-Magnetic Telegraph, with the Reports of Congress, and a Description of all Telegraphs known, employing electricity or galvanism. Illustrated by eighty-one wood engravings. By Alfred Vail, Assistant Superintendent of Electro-Magnetic Telegraph, for the U. S. Philadelphia: Lea and Blanchard, 1847.] —8vo., 208 pages. Woodcuts.

1847—ANONYMOUS.—

[Hand-Book to the Electric Telegraph. Being a popular explanatory Treatise on the construction, nature, and powers of this Wonder-working Instrument, with a full account of its origin and progress. Second edition, with additions. London: Published by W. Scales, 195, Shoreditch; W. M. Clark, Warwick Lane; and sold by every Bookseller, and at all Railway Stations in the Kingdom, 1847.]—Pam., 12mo., 27 pages.

The third edition, without date, gives a description of the Central Station at Founder's Court, Lothbury. It describes wires covered with lead, and testing posts, and gives a list of Electric Telegraph Company's Stations. Note: Lothbury Station was opened January 1st, 1848. See *Mechanic's Magazine*, January 8, 1848.

1847—PHIPSON, T.—

[Wonders of the wire. A Manual of the various Electro-Magnetic Telegraphs at the present in use. By T. Phipson. London: J. Gilbert, 49, Paternoster Row; Glasgow: J. M'Combe, 14, Buchanan Street.]—Pam., 12mo., 28 pages.

No date on title. Advertised as "just published in *Mechanic's Magazine*, July 3, 1847.

1847—ANONYMOUS.—

[An account of the Electric Telegraph now in use for Railways and other purposes, extracted from the "Engineer's and Contractor's Pocket Book," for 1847 and 1848. London: John Weale, 59, High Holborn, 1847.] —12mo., 20 pages. Cuts.

1847—STEVENSON, W. F.—

[Most important Errors in Chemistry, Electricity, and the phenomena of Electricity and the Polarity of the Magnetic Needle, accounted for and explained. By W. F. Stevenson, Esq., F.R.S., F.S.A. Second edition, revised, with material additions. London; James Ridgway, Piccadilly, 1847.]—Pam., 8vo., 68 pages.

1847—HIGHTON, E., Esq., C.E.—

[On the Effects of Atmospheric Electricity, as exemplified by the Storms of the Summer of 1846. By E. Highton, Esq., C.E. Published by the Society of Arts, in their Transactions for years 1846-47.]—Small 8vo., Pamphlet, Illustrated.

1848—BIRD, Golding.—

[Elements of Natural Philosophy, being an experimental introduction to the study of the Physical Sciences. By Golding Bird, A.M., M.D., F.R.S., F.L.S., &c. The third edition revised and enlarged. London: John Churchill, Princes Street, Soho, MDCCCXLVIII.]—Small 8vo. Woodcuts.

Chapters x "Magnetism" xi to xx "on Electricity."

1848—HARRIS, Sir W. Snow.—

[Instructions for the application of permanently fixed conductors of Lightning to Her Majesty's Ships. Drawn up for the use of the Royal Dock-Yards. By Sir. W. Snow Harris, F.R.S. &c. Printed by order of the Lords Commissioners of the Admiralty. London: Printed by W. Clowes and Sons, 14 Charing Cross for her Majesty's Stationery Office, 1848.]—8vo., Pam. 19 pages, coloured plates.

1848—ANOMYMOUS.—

[The London Anecdotes for all readers. Anecdotes of the Electric Telegraph. London: David Bryce, 86, Fleet Street.]—12mo., 128 pages.

No date or title. Preface dated, April 25, 1848.

1748—KNIGHT, Gowin, F.R.S.—

[An Attempt to Demonstrate that all the Phenomena in Nature may be explained by two Simple Active Principles, Attraction and Repulsion. Wherein the Attraction of Cohesion, Gravity, and Magnetism are shown to be one and the same, and the Phenomena of the latter are more particularly explained, by Gowin Knight F.R.S. London; Printed in the year, MDCCXLVIII.]—4to., 91 pages.

SPECIFIC AND LATENT HEAT.

In talking and writing about heat, physicists have felt the need of some mode of expressing a definite quantity, and the idea was suggested of calling that quantity which is sufficient to raise the temperature of one pound of water one degree of Fahrenheit's scale a *unit*. Having exactly defined a given quantity of heat, it is surprising to find how many truths in relation to the action of caloric may be briefly and clearly expressed, which before it was difficult to comprehend and convey. It is an impressive illustration of the value of accurately defined terms in scientific discussions.

Specific heat, for instance, may be explained in a very few words by the medium of units. A unit of heat will raise the temperature of a pound of water one degree; but it will raise the temperature of a pound of mercury 33°, and of a pound of tin 20°; or it takes one thirty-third of a unit of heat to raise the temperature of a pound of mercury one degree. We accordingly say that the capacity of mercury for heat, or its specific heat, is one thirty-third, or three one-hundreths, expressed decimally 0·03, and that of tin is 0·05.

A clear idea of *latent heat*, also, may be briefly conveyed by means of units. To raise the temperature of a pound of water from 60° Fah. to 212°, the water must absorb 152 units of heat; then it will absorb 1,000 units more without raising its temperature at all; but these 1,000 units convert it into steam. As this heat, which changes the water from the liquid state to that of vapour, does not show itself either to the touch, or when tried by the thermometer, it is called hidden or latent heat.

A unit of heat applied to *mechanical effort* will raise 772 pounds of matter one foot; in other words, it will perform 772 foot-pounds of work.

As it takes more heat to raise the temperature of water one degree at some temperatures than it does at others, it was necessary to fix some temperature at which the measure should be taken, and 60° Fah. has been agreed upon, water at that temperature being easily obtained.—*Scientific American.*

EXTRACTS FROM THE EVIDENCE OF PROFESSOR W. THOMSON, LL.D., F.R.S., BEFORE THE GOVERNMENT COMMITTEE.

"Soon after you became a director of the Atlantic Telegraph Company, was your attention directed to the conductivity of copper?—Yes.

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You instituted a series of experiments, did you not, to determine the variation of this quality in different samples of copper?—A number of samples of copper were, at my request, put into my hands for the purpose of measuring their conductivity, in consequence of my having accidently noticed differences greater than I expected in the conducting power of one or two samples which I had had previously.

Will you be good enough to state the general results at which you ultimately arrived, and your modes of experimenting?—My modes of experimenting did not differ materially from the methods which had been followed by certain other experimenters, especially in Germany, and were in reality all based on Professor Wheatstone's invention of a beautiful method for comparing resistances, to which I have frequently referred as Professor Wheatsone's electric balance.

What were the results at which you arrived?—That different specimens, chosen at random from the stock supplied for manufacture, differed immensely in conducting power.

Although nominally the same quality of copper?—Yes, although nominally the same quality of copper. All those specimens of wire were supposed to be of the very best quality, the only copper supposed to be good being that which admitted of being drawn into wire suitably for the purpose. A good mechanical quality was necessary to prevent frequent fractures in the wire-drawing, and to understand that, I should say that hanks in unbroken lengths amounting to a large mass were always required, the worse metal being found to break before it could be drawn into a hank of a certain size. The mechanical qualities seem to have been satisfactory, but no suspicion whatever was entertained that there were also large differences in electric conducting power. W. Weber had many years before pointed out considerable differences in different specimens of copper wire which he had tested. I found differences much exceeding those; and I did not, as I expected, find any approximation to a uniform average among the different specimens tested; some specimens I found nearly double in their conducting power, compared with others, reckoned according to the weight and length, allowing for the variations of gauge. Calling the best specimen which I had in the summer of 1857, 100, I found many specimens standing at 60 in specific conductivity, many standing at 50, many standing at 80, a few above 80; and, so far as I can recollect, the average of a large number of specimens that I then examined may have stood between 60 and 70, but I consider the statement of such an average to be of no value, it is so much a matter of chance. If I had received a dozen specimens of a low quality below the average, or if I had chanced to receive a dozen specimens of a higher quality, the average would have been so much the lower or the higher. I never had an opportunity of measuring the conductivity of 200 or 300 miles of submarine cable; such alone would have given me exact information as to the average for that portion of cable. I may mention that a month or two later, still in the summer of 1857, I received specimens of wire which were in stock for submarine telegraphs, for some of the Mediterranean telegraphs, I believe, which stood as low as 43 on that scale; and, lastly, I may mention that I have since met with specimens standing two or three per cent. above the 100, and an artificial alloy, which I had prepared, stood, so far as I can estimate, as high as 113.

What was that alloy?—The alloy consisted, so far as I can recollect, of copper and a quarter per cent. of lead. I have made experiments upon a series of alloys, in all about 43 or 44, and have recently repeated the examination so as to arrive at accuracy, within certain limits; and I expect, immediately, to be able to communicate to the Royal Society, for publication, the results. A few months ago I sent a provisional list of the specimens, shewing the relative conductivity of those alloys, but, possibly, requiring correction as to the absolute conductivity stated. That list was communicated to Mr. Latimer Clarke, and, I believe, a copy of it was laid before the Committee.

Professor WHEATSTONE.—Were you quite certain that you employed pure copper in your experiments?—I could not be quite certain.

The copper might be alloyed with other things than metals; it is not very probable that it might contain some sub-oxide, and that the mixing of lead afterwards with it might have reduced the sub-oxide, and therefore have given it a higher conducting power on that account?—That is possible. I cannot say that I am at all satisfied that the experiments which I have made point out distinctly the relation between the ascertained chemical combination, and conductivity. I may mention that one of my alloys was made with a sub-oxide melted with the copper; but the uncertainty of the process of melting the sub-oxide, and the uncertainty as to how much of the oxidation may have disappeared in the melting, prevented me from attributing much weight to the experiment."

"CHAIRMAN.—Can you say if the whole of the strand of the Atlantic cable had been selected according to your recommendation, whether the speed of transmitting signals would have been materially increased or not?—Certainly very much increased—increased by at least thirty per cent. I believe that the last 400 miles were considerably better, possibly 10 or 20 per cent. than the first part of the cable. Mr. Whitehouse estimated the gain in conductivity, owing to the adoption of my suggestion, to have been 25 per cent., I believe, but I am not aware of the experiments upon which he founded his estimate; but of this I am sure, that by selecting the specimens rigorously, and only choosing the best quality, 25 per cent. above the whole average speed of the Atlantic cable would have been secured.

To what extent would the strength of the signals received at the end of the cable distant from their transmission have been improved by selecting copper according to your recommendation?—With the insulation perfect, the strength of the signals would have been improved by improved conductivity, in the ratio of 70 to 100; the proportionate improvement in the strength of the signals will be in reality greater, however, in consequence of the loss by defective insulation being nearly the same in absolute amount of leakage from the wire of low, and from the wire of high conductivity."

"CHAIRMAN.—From your experience in the continuous passing of currents through the cable, and other sources of observation while on board the *Agamemnon*, did any misgiving arise, towards the completion of the work, that the cable was, to some extent, in a faulty condition, and must have been so before its submergence?—I had the very strongest misgivings as to the condition of the cable from the Monday forenoon of the laying. I may mention, in the first place, that we had a loss of continuity on the night of the commencement, accompanied with certain very singular circumstances; the whole circumstances I have described in a short paper which I wrote on board the *Agamemnon*, at the request of Captain Preedy (Appendix No. II.), and which has recently been published in the *Civil Engineer's and Architect's Journal*, in a report of a discussion which took place at the recent meeting of the British Association.

What was the general result of that statement?—The signals suddenly ceased altogether at a certain instant, the testing shows improved, rather than deficient insulation, at the very time the operations were going on in the hold with a view to protecting the portion of the outside sheath (which had got damaged) from the risk of fracture in going out. It seemed most natural to suppose that the breach of continuity in the interior conductor, which these tests demonstrated, was in the damaged portion of cable actually in hands in the hold, since this portion had been bent about so much as to displace the outer strands of iron wire, in consequence of the rough weather of the previous trip. Accordingly the cable was pricked into very close to the outgoing part, with a view to testing whether the breach of continuity was on board the ship or not on board the ship. The result was, that there was almost perfect insulation exhibited when the battery was applied to the conductor, at the part where it was pricked into. It was perfectly certain then that a portion of the wire at fault was broken inside the gutta percha, between the part pricked into and the *Niagara's* end of the cable; and from the very great perfection of insulation which I found, it was quite certain that the distance of the fractured point could not be great. It was in the paid-out part, or else on board the *Niagara*, and I endeavoured to ascertain whether it was on board the *Niagara*, or in the paid-out part; but the imperfection of the apparatus which I had at command, prevented me from making more than a guess. I made a rough estimate, by comparing the result of an experiment I had made the day before, with a view to the possibility of such a contingency, by means of one of the common detectors. I found that the discharge after charging by the battery, and then discharging through the galvanometer, was such as was consistent with the supposition that something more than 50 miles, and less than 150 miles, if I remember rightly, might be the locality of the fracture."

"CHAIRMAN.—Do you consider that these faults were due to a defective construction of the cable, or improper use of it before it was laid, or to the fact of it being laid in deep water?—Certainly not to the fact of its being laid in deep water; most probably to the injury in the manufacture, either from mechanical injury or from overheating.

Or from the repeated coilings and uncoilings?—I have no idea that repeated coilings and uncoilings can do any harm whatever to a piece of sound cable; but repeated coilings and uncoilings may finish the development of a fault if there has been a portion of the gutta percha defective previously; for instance, if the wire is very nearly through the gutta percha, or very eccentric in any part, the coiling and uncoiling may make it go through, or if there has been a ragged wire from bad joints, the coiling and uncoiling might make it protrude; but no amount of coiling or uncoiling, and no amount of mechanical

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strain in the way of kinks that a cable ever experiences in being paid out, or afterwards in laying itself on the bottom, as it does very much in kinks I believe, can possibly do any harm whatever, in my opinion, to a piece of sound gutta percha core.

Mr. VARLEY.—Was the cable submitted, do you think, to any temperature which might be dangerous previously to the laying?—On the experimental trip there was an alarm one evening that some warm water from some part of the engine had got into the hold in the neighbourhood of the cable, and it was feared that it might reach the cable and do damage. I necessarily made close tests, first from one end of the cable and then the other, and I could not convince myself that I ascertained for certain any variation whatever at the time. The cause of that accident was quickly done away with, and I feel perfectly convinced that the cable suffered no damage whatever on the occasion. I continually tested both ends from that time forward of the coil on board the *Agamemnon*, and never found any indication whatever of the cable having suffered damage. On the contrary, if I remember rightly, the lower end generally insulated a little better than the upper end in all the tests that I made on the homeward voyage of the first attempt, and on the outward voyage of the successful attempt. I cannot speak for the damage that the cable may have possibly experienced in being coiled out of the store at Keyham into the ships, but I do not think it at all probable that it experienced any; the only way in which it could have experienced any damage on those occasions was by possible exposure to the sun; but there was no sun of sufficient intensity to allow damage to occur, with such precautions as were taken: a large part of the cable was injured by exposure to the sun in one of the manufacturing yards a year before, but I believe there was no damage of that kind experienced afterwards."

"How long did the Queen's message take in transmitting?—It was stopped in the middle, and a great many parts were repeated over and over again, therefore, I cannot say what was the time; but it was sixteen hours from the time it was begun till the time it was finished, and perhaps even more than that.

Is it your opinion that the electrical state of the cable was made worse by the use of induction coil power, or battery power, or either of them?—Most probably it became worse more rapidly than it would have done if the fault had been altogether undisturbed.

By the use of induction coils?—Certainly, either one or the other. My opinion is that the use of induction coils is very dangerous in a case in which the gutta percha is very nearly pricked through, but I do not think that induction coils could do very much damage, or be worse at all events than battery power at a great distance. I do not think that the induction coils would produce a worse deteriorating effect on a fault already formed than battery power at 300 miles distance for instance.

What would you use to send messages through cables, if both battery power and induction coils are injurious?—I would have the receiving instruments made as sensitive as possible, and I would use the lowest battery power that could be got to move them if any doubt existed as to the condition of the cable.

Mr. SAWARD.—Would you use magnetic electricity?—Nothing but direct battery. As far as I can see at present, the use of direct battery can be made much safer and milder in its effects upon the cable than any system of induction coils. At the same time the magnetic system, I believe, has, to a certain extent, the safeness of the battery in being comparatively mild, milder than the action of induction coils depending upon a sudden break of the primary circuit. The use of a magneto machine, somewhat like Mr. Henley's, I do not consider could be dangerous to the cable. I prefer the battery, because I think a battery can be managed both for rapidity of signalling and the security of the cable, so as in all respects to be preferable to either the magneto machine, or the induction coils.

Mr. SAWARD.—It would be slower in its operations, you could not get signals through it as rapidly as with the coil power, could you?—More rapidly when rightly directed, but when used simply with the Morse key, it would depend upon the adjustment of the instruments with which it was used, and the system of contracts used.

CHAIRMAN.—What is the minimum amount of battery power that you think would move your marine galvanometer, giving a readable signal through the Atlantic cable if it were perfect?—One cell would give, through a well insulated cable of the same length and gauge, a current strong enough to produce about six scale divisions of deflection in the improved galvanometers I have at present; and would, therefore, be sufficient to give even tolerably rapid signalling at sea. My land mirror galvanometer can be made one hundred times as sensitive without becoming too slow for signalling at a rate of two or three words a minute. With the Atlantic cable, if I had a power of from 20 to 50 cells, I could secure very rapid signalling by a proper arrangement of battery contacts."

"Mr. SAWARD.—Should you consider that the mechanical effect of the pressure of the sea upon the gutta percha would be to force the pores of the gutta percha closer together, and thereby make it a better insulator, or to cause the water to permeate those pores and get to the copper wire?—If there is a flaw, I believe that the pressure will tend to send the water in.

If the cable is laid in a perfect state?—If the cable be laid in a perfect state, I do not think that any amount of pressure of the water upon it would give any tendency whatever to let water get through the covering to the copper wire."

"You think water will not penetrate gutta percha when submitted to it equally on every side?—I am firmly of opinion that it will not, judging from the general properties of matter, and the constitution of gutta percha.

To come to the general question of conductors and insulating substances, will you favour us with the deductions you have arrived at from experience; and, first, as to the proper size of a conductor best adapted for rapidity of transmission in cables of the lengths respectively of 1,000, 2,000, and 3,000 miles?—It is impossible to give a general answer as to the question for a thousand miles, there are so many circumstances to be taken into account; but for two thousand and three thousand miles' length, I should say that the largest diameter of gutta percha sheath that is advisable should be first considered; that must depend upon the mode of laying that is to be followed, whether it is to be laid in one length, what stowage room can be had in the ship, and, if not limited by those considerations, next must be considered to what expense it is desirable to go, deciding by such combinations of considerations, what is the best outer diameter of gutta percha. Then, I think, the diameter of the copper ought to be kept considerably within a certain proportion of the diameter of gutta percha, which is determined as giving the maximum speed. The reason that I say that it should be kept within that is, that a considerable deviation from the maximum will make very little deviation in the speed, while diminishing the size of the copper wire is advantageous in two ways,—first, by lightening and diminishing the specific gravity of the cable; and secondly, by increasing the thickness of the insulating medium, and so diminishing the risk of flaws, especially by preventing the copper wire from having the same tendency to go through the gutta percha in bending that it may have if there be but a very thin coating of gutta percha around it. That maximum I calculate by a simple process from a logarithmical formula which I shall communicate to the Committee in writing, as also a table of the speeds depending on greater deviations from the maximum. (See Appendix No. III.) Judging from that table, then, I would take the diameter of the copper wire within that which gives the maximum speed, so as not seriously to diminish the speed, but at the same time so as to considerably diminish the weight of the copper wire. The diameter of the conductor, which I find would give the maximum speed of signalling is, as shown in the tables, somewhat over three-fifths of the outer diameter of the gutta percha. A copper wire half the diameter of the gutta percha would give 94 per cent. of the maximum speed; and a copper wire two-fifths of the diameter of the gutta percha would give 80 per cent. of the maximum speed. With farther diminution of the diameter of the conductor the speed falls rapidly. It should not be forgotten, however, that to improve the conductivity upon what it has been hitherto in all cables is the first thing to be done, to increase the speed, and has none of the danger attending a too great increase of the mass of the conductor."

"In consequence of what has occurred with respect to the repeated failures, the ultimate success, and again the failure of the Atlantic cable, has your confidence been shaken in the future permanent success of a properly constructed and properly laid Atlantic cable?—My confidence has not been in the slightest degree shaken.

Do you consider that there are any great or serious obstacles, after the experience which has been gained, in the way of making and laying such a cable for the Atlantic line as would be permanent?—I do not think that there are any serious obstacles whatever. I consider that there are difficulties to ensure freedom from flaws in the manufacture.

That is a question of good business arrangements and proper attention?—Entirely so. I consider that a cable might be laid with the very best possible prospect of success, with very small chance of damage. across the Atlantic. I believe that a cable might be laid now with certainty."

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The Student.

A MINIATURE GROVE'S BATTERY.

THE first nitric acid battery constructed by Mr. Grove was composed of a cylinder of platinum, ¾ths of an inch high, contained in an egg-cup, and surrounding a tobacco-pipe bowl in which was placed a strip of amalgamated zinc, an inch long and a quarter of an inch wide. The platinum was "excited" with strong nitric acid, and the zinc with dilute sulphuric acid. This miniature couple was sufficiently powerful to give a spark on making and breaking circuit, and readily to decompose acidulated water. A series of six similar cells, if neatly constructed and efficiently arranged, will often be found useful by the electrical student; for, although such a battery does not possess the constancy of the admirable arrangement of Daniell, it gives, in a small space and at little cost, the means of obtaining a current of very considerable power—either of "quantity," through a small resistance of wire, or of "tension," where the resistance in the external portion of the circuit is greater. In the former case the platinum elements should be connected together, and the zinc elements also united with each other, when the six cells become equivalent to one cell of larger surface. Where tension is required, the platinum element of each cell (excepting one terminal cell) should be connected to the zinc of the following cell, *et seriatim*, leaving an unconnected zinc at one extremity of the series, and an unconnected platinum at the other extremity, as the negative and positive poles of the battery. This will be well understood by most of the students of the ELECTRICIAN. A convenient mode of arranging the connections, so as to be able to vary them at will, is as follows:—The six cells being placed consecutively in a box or trough of wood, six small binding screws, or (what answers the purpose almost as well) six small pieces of lead pierced with a cylindrical hole, are fastened at intervals in the upper portion of each of the two sides of the box. The positive elements are connected to the set of binding screws on one side, and the negative elements to those on the other side. The positive elements may now be all connected together by passing a wire through the apertures in one set of binding screws, or of the substitute for them; and the negative elements may be connected in a similar manner. Or, when tension is required, five transverse pieces of wire are made to connect the positive and negative elements of the alternate couples. The cells may also be coupled for quantity, two by two or three by three, and a tension series of three double or of two triple cells formed by connecting the opposite poles of the compound couples.

We will describe the method we ourselves adopted in constructing a little battery on the above plan, leaving our readers at liberty to follow any modification of the same which may best suit their convenience or mechanical skill. The materials required for the six cells are:—

A piece of platinum foil 1½ by 1 inch (cut into six strips 1 by ¼).
A strip of stout zinc plate 19 by 1½ inches (for six cylinders 1½-inch high).
Six pipe bowls (the bowls of German clay pipes are the most suitable in shape).
Gutta percha for the outer vessels and covers.

When very small earthenware jars are not readily obtainable, the outer vessels may easily be made of gutta percha, by those who have acquired a little skill in manipulating this material. To those in whom this skill may be wanting, the following hints may prove useful in enabling them to construct many little pieces of apparatus, which would be expensive to purchase:—

Procure a glass vial 1½ inch in diameter; place a piece of gutta percha, or a sufficient quantity of fragments of the same, in boiling water; when thoroughly plastic, knead the material before the fire until it becomes a homogeneous and adherent mass; place it again in hot water, then roll it into a cylinder, flatten it on a smooth wet surface, and with the glass vial roll it into a thin sheet or strip; while yet warm, cut this to the required width (about 1½ inch) with a pair of scissors, divide the strip into lengths (of about 4½ inches) to form the cylindrical portion of the outer vessels, and place the lengths in warm water. They are now to be moulded into a cylindrical form upon the glass vial, and a red-hot knife passed between the edges, which may then be made firmly to adhere. When the cylinder, still upon the vial, has been dipped into boiling water, and rolled upon a smooth surface, it may be placed in cold water, and detached. Six circular pieces are to be cut from the sheet gutta percha, to form the bottoms of the vessels. Pass a red-hot iron over one of the extremities of the cylinder, and place it upon one of the circular pieces, previously slightly heated before the fire. The two pieces will adhere, forming a very neat and durable vessel. Care must be taken, however, not to mix sulphuric acid and water in this vessel, as the heat thus produced would be sufficient to destroy it.

The six outer vessels having been thus constructed, we have now to form a cover for the porous pipe-clay vessels, which will answer the purposes of keeping the platinum strips in position, and preventing, to a great extent, the escape of nitrous vapours and loss of acid by evaporation. The aperture in the broken portion of the bowl should be plugged with wax or gutta percha. A narrow strip of plastic gutta percha is then moulded round the inner edge of the pipe bowl; and, when cool, is touched with a hot iron, and made to adhere to a circular piece of gutta percha, previously warmed, of somewhat greater diameter than the aperture of the bowl. If the latter has been previously dipped in water, the cover, which may be made quite air-tight, is readily detached. The original position of the cover upon the bowl may be indicated by a pencil mark.

The platinum elements are now to be attached to a short piece of lead wire, or to a piece cut from a sheet of lead, passing through an aperture in the centre of the cover. An incision may be made with a knife in one extremity of this wire, in which the foil is fixed by a blow from a hammer. A piece of platinum wire, one extremity of which has been twice coiled round a knitting-needle, would be, perhaps, a better material; but the lead may be protected from the action of the acid by melting a little wax upon that portion which is inclosed within the cell.

The construction of the zinc cylinders presents but little difficulty. The metal, previously warmed, may be hammered into the required form upon a cylindrical piece of wood. A projecting arm of metal should be formed upon the cylinder, to which a copper wire may be attached. To amalgamate the cylinders, they should be dipped in a mixture of one part sulphuric acid to three of water, and a globule of mercury may then be made to spread over the surface; but the upper portion of the cylinder, with the projecting arm, should not be immersed in the acid, as otherwise the latter would inevitably break off, owing to the brittle character of the amalgamated metal.

To charge the cells, mix one part of sulphuric acid with four of water, in a separate vessel, and, when cool, fill the outer vessels with the acid mixture to one-third their capacity. Place the amalgamated cylinders in the fluid, and within these introduce the porous vessels containing the platinum elements, having previously nearly filled them with strong nitric acid. The projecting covers of the pipe bowls will prevent their contact with the zinc, and maintain them in their position in the centre of the cell. When arranged for quantity, the battery should give a bright spark when contact is made and broken; and when connected for tension, should give a stinging sensation to the tongue when the terminal wires are placed upon it. The battery will remain in good action, without fresh charging, for eight or ten hours, although it becomes gradually weaker after the first hour.

THE ATLANTIC TELEGRAPH COMPANY.

ON the 7th instant a meeting of shareholders and others interested in the above company was held at the Public Saleroom, in the Liverpool and London Chambers, for the purpose of hearing from the Right Hon. Stuart Wortley an explanation of the existing position and favourable prospects of the important undertaking of establishing an Atlantic telegraph communication. There was a large attendance of gentlemen. Sir William Brown, Bart., was called upon to preside, and he briefly introduced Mr. Wortley to the meeting.

The Hon. Mr. Wortley commenced by observing that he found himself rather embarrassed on being called upon to address a meeting like that on his immediate arrival—for he had but that moment arrived from London—and he had not come prepared with any speech to deliver to them, nor probably would they desire that he should so detain them. However, he should have no difficulty in giving them any information he possessed upon the very interesting subject relative to which they had met; and if he failed to give them the information they desired to elicit, he should feel obliged by gentlemen addressing questions to him, and any information which he had, or which the board he had the honour of belonging to had, he should be most happy to impart. What would gratify him most would be if he could impart to them some of that not only well-considered, but, he hoped, that perfectly established confidence he felt in the great enterprise in hand. He had not come to dilate upon the merits of the scheme which existed for connecting the two countries by the Atlantic cable. They were, to their intelligence, well known. The only thing wanted to be thoroughly well known was the brightness of the prospect of success, if they could get the capital to make the next adventure. From his long connection with the company in its most desponding times and difficulties, and urged by the importance of the subject to inform himself upon it and investigate the probabilities of the success of laying a cable which should not only unite the two hemispheres of the globe, but also be remunerative

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to its proprietors, he had come deliberately, and after the fullest consideration, to the strong and confident opinion that in establishing that great national work they should not only benefit every nation on both sides of the Atlantic, but should at the same time earn the gratitude of all nations, and receive a remuneration which he did not wish to exaggerate, but which would remunerate all who came to assist in the undertaking. He did not venture to appeal to them on the ground of the great national and political importance of the scheme, or the vague ground of its commercial importance. It would be necessary that a large commercial community like that should be convinced that they were not again throwing their money into the Atlantic for nought. Therefore, for that purpose, they had consulted the best authorities in science, in practical engineering, and electricity, and every one who had had experience in laying cables in every part of the world; and it was from that information, not from any theoretical or fanciful views, they had derived that confidence in the project which they so fully possessed. He was satisfied he was addressing one of the greatest and most important communities in the kingdom; and he felt satisfied that if they received their support, success would be certain. The sum they asked at the hands of the public was not so much a consideration, if they were satisfied that the project would be a successful undertaking. It was admitted on all hands, from the Prime Minister downwards, that not only was this a great work, but if the cable was successfully laid there would not be a commercial man they could meet with but who would be highly remunerated by it. There were a hundred and fifty thousand miles of telegraphic wire laid throughout the continent of Europe, and extending into Asia, and forty thousand miles at work on the continent of America; and these were daily extending themselves, shooting off suddenly to every point, and increasing in number and extent so rapidly that when the unhappy war in America was stayed—as with God's blessing they all hoped soon to see it stayed—there was no saying to what extent the scheme would spread. But it wanted one link, and that link was the Atlantic telegraph; and from the moment that was established, and they had also the numerous wires on this side, and those branching off on the other side, brought into operation along with it, it was impossible not to see that that would lead to an amount of traffic large and ample, if not excessive, and would probably have the effect of bringing other competitors in the same direction. The only thing they had to do was to convince the public that the former failure could be accounted for—that the extent of its success was almost miraculous under the circumstances. The advance of intelligence, the spread of science, the increase of experience, and the increased facilities obtained by new experiments, were such as to make that which failed in 1858 a safe and sound commercial enterprise in the present day. They would perhaps be glad to know what was the feeling on the subject in other great commercial communities. So far as he had been enabled to collect it, it was very much changed, and was now much more favourable not only to what it was at the time of the original attempt, but to what it was some few years back; for their views were now received not only with patience and respect, but there was a desire manifested to assist in carrying them into operation. They invited subscriptions to the extent of £300,000, and, eventually, if they could get it, they should require £600,000 to effect the thing as it ought to be He was bound to admit that the subscriptions had not come in so rapidly as he could wish; but it was not more than ten days since their prospectuses had been issued, and they had not yet reached the greater proportion of the commercial community. At the last moment he left London the subscriptions amounted to £130,000. For some small portion of that sum they were indebted to the community of Liverpool, but the main part was from the principal houses in London. They were spreading information—visiting the great houses and capitalists; and wherever they went there was a great disposition to assist them, and subscribe capital; and they had promises held out by gentlemen who said they would consider the matter, and give an answer in a very few days; and the directors hoped there was a very considerable sum behind the amount he had stated. It was not only satisfactory that the money was coming, but that it was coming from the right classes, not from mere speculators. In fact, the enterprise was not a mere vulgar speculation; it was mingled with higher considerations. A man of intelligence must see that the indirect benefits resulting to commerce would be so eminent that it could not but redound to their profit ultimately, and prove remunerative also to those who had invested their capital in the scheme. The greater portion of what had been subscribed had come from such houses as Baring, Overend, Jones, Lloyd and Co., and other such houses; and the very last that gratified him was the name of a gentleman not in the habit of speculating at all, but who exercised a great influence over a large and influential money class—he meant the individual partners in the firm of Coutts and Co. He did not mean to say but that there were some small sums subscribed, and these small amounts were gratifying. He thought these justified the course which the directors had pursued; and instead of, as in the first instance, gentlemen like the chairman subscribing, which made it almost a private enterprise instead of a general speculation, they had appealed to the general public, by reducing the shares from £1,000 to £1, in order to enable any intelligent man who had a few pounds at his disposal to take a part in that great national concern. But they did not disguise from themselves that it was from the class which he then saw before him that the projectors looked for the greatest amount of support. He himself hoped—he would say he felt confident—in the course of the next fortnight, to see a different state of things—to see their subscription-list filled with names from all parts of the country—a subscription-list which would realise the £300,000 to start with; and if they arrived at that point the thing could not drop through. They might need more money, but the Governments of America and England, to say nothing of other Governments, would never allow it to drop through if the commercial community would give their sanction by raising the £300,000. They (the Governments) said they would not take the lead in the matter; let the commercial world give the scheme their stamp and sanction, and then they would consider what assistance they could afford to give. That, he believed, was the spirit in which the Governments regarded the matter. It had been under the consideration of the Cabinet more than once; and he believed he was justified in stating that what he had said was the spirit of the English Government and that of the United States. The President, in his last message to Congress, having a high opinion of the importance of this project, had sent a despatch to Mr. Adams, the American minister in London, requesting him to urge upon the British Government to join them (the Government of America) in the enterprise; and although the British Government had postponed the consideration of the matter, and said the time was not yet come, yet he (the speaker) knew from private information that the project had been under the consideration of Government, and that they were favourable to it. The directors appealed to the English public—to the commercial public, and there were other sources from which, if necessary, contributions could be derived. A Dutch gentleman, whom he had met that morning in the railway carriage, encouraged him to go to Amsterdam, if he could not succeed in getting the amount of subscription, in England, as there, his informant said, he felt assured the project would be favourably received. Last summer he (Mr. Stuart Wortley) had the honour of an audience with the Emperor of the French, and nothing could be more cordial than the reception he met with. He (the speaker) was not prepared at the time to submit any scheme to his Majesty; but he, perhaps, flattered himself when he said he believed that he had interested the Emperor very much in the undertaking. The Emperor was at the time embarrassed with having committed himself to a French company having for its object a similar design, and he referred him (the speaker) to his ministers, to know in how far he would be justified in committing himself. That company (the French one) was not yet before the world; but it had for its object the taking of a line which he (Mr. Wortley) would have considered to be in a much more dangerous direction, but it was the only one which, as a French company, they could take, for the English company, through all their time of despondency, had preserved intact their privileges and rights, and had the exclusive right of laying cables on the shores of Newfoundland and Labrador. The French company proposed to go by way of the Azores; but the volcanic action in that quarter of the world, and other dangers connected with it, were well known at the time through the medium of the newspapers. He hoped, however, if necessary, it would be possible to get the co-operation of France and other continental nations, if this project was established. But he did not wish to place this foreign assistance idea too high, because he felt sure that British enterprise and energy would be sufficient to carry out the undertaking. He only mentioned it to show the general interest that had been excited, and the general belief in the practical character and operation of the great work they had then in hand. He was ready to give any information within his reach, and he thought he should be able to satisfy any shareholder of the old or the new company that the course the directors were taking was a prudent one, and that everything was being done to ward off disaster and secure success. With regard to the failure of the first attempt, there were probably some present who knew that it could well be accounted for. The ignorance of the subject at that time, the want of knowledge of the bottom of the Atlantic—more especially of the sides where the cable was to be laid—the great want at that time of the knowledge of all the departments of submarine telegraphy (which had now been supplied by the experience of the years which had since elapsed, and the application of the scientific knowledge of the greatest practical men who had given attention in every quarter to all the modes of operation and means of effecting the object in view), had led to failure; but the inventions, improvements, and amount of knowledge on the subject now at their disposal would, he believed, secure success. The board at London were for a long time left to themselves. They had great difficulties to contend with, but they had never abandoned hope; they had kept their mind steadily fixed on the object in view, and had determined that such an enterprise should never sink or die while life and breath remained in it, and they could keep it alive. He believed the time had come when detraction could do them no injury—for the more the matter was discussed, the greater would be the public confidence in the object. He only hoped that they would allow him to go back to London with the assurance that there was as great an interest exhibited in this scheme here as there was amongst the great money lenders in London; and that they would see that it would not only redound to their credit, honour, and the spread of civilisation throughout the world, but that they would heartily exert themselves, and would use their influence amongst their friends to obtain those subscriptions which, as a matter of business, was the only means of insuring success.

The Chairman said he had the fullest confidence that the board in London would do all that the hon. gentleman (Mr. Wortley) expected, and all that any board could do to promote the interest of the subscribers. He

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felt deeply interested in the undertaking, not only as a commercial speculation, but as a national one; and he considered it the duty of all present to encourage, as largely as they could, an undertaking which would unite the two great continents together. Looking at the vast chains of railway which intersected the country, he did not think that one line of cable would be sufficient, but that it would soon be found necessary to have a second, and even a third. If those engaged in the scheme lost £100 or £200 each, it was only a game of bagatelle compared to the advantages that would accrue to the country from such an enterprise (hear, hear.)

Mr. J. C. Ewart, M.P., in thanking Mr. Wortley for the explanation he had given them, observed that this was not only a great national but a great local undertaking, and no one could have the least doubt that, if the money was subscribed, it would prove a most profitable one (hear, hear). He himself had already £1,400 quietly sleeping at the bottom of the Atlantic (laughter), but he could only say that he had another £500 to invest; and if every gentleman who felt as he did would come forward in the same way, there was no doubt that the undertaking would be carried out. The difficulties that formerly existed had now been got over, and he had no doubt that success would be awarded to the undertaking (hear, hear). The hon. member concluded by moving a vote of thanks to Mr. Wortley.

Mr. Wortley, in responding, took occasion to contradict a representation that had been made, to the effect that the directors had entered, or desired to enter, into connection with the Electric and International Company. There never had been, nor was there at that moment, any idea or attempt to make arrangements with the Electric, or any other company (hear, hear); and as far as his influence could go, he never would encourage any exclusive connection. His hon. friend (Mr. Ewart) had told them that he had £1,400 at the bottom of the Atlantic. He (Mr. Wortley) was sorry to say that he had more; but the thing for them to do was to raise the money. In the cable it was at present down at the bottom of the Atlantic; but they must try to get it up, try to mend it, try to put life into it, and try to float it to the surface; and to accomplish this there was no other means but subscribing to this company (hear, hear). If they were successful in laying the new cable, they would resuscitate the old capital, and that which was at the bottom of the Atlantic would rise in a sufficiently substantial form to prove remunerative (hear, hear, and cheers). There was also an impression that the directors had fixed upon some particular cable, and that they were going to lay down a foolishly heavy one. That impression was wholly unfounded. The directors had obtained the assistance of Mr. W. Fairbairn, the late president of the British Association; Mr. Whitworth, of Manchester; Professor Wheatstone and Professor Thomson, of Glasgow. These gentlemen formed a consulting committee, and before any cable was selected it would be submitted to them for their advice as to which they believed to be the best and most promising, and in all probability the cable they selected would be the one that would be adopted.

Mr. Bald said there was a very general impression that the old cable had broken. He believed that it did not break; and if Mr. Wortley could give them any information upon that point it would be desirable.

Mr. Wortley replied that the previous scheme was undertaken at a time when knowledge of the subject was imperfect, and the cable was necessarily manufactured in great haste. Two manufacturers were employed to construct the cable at the same time; and so little communication and understanding existed between the two firms that one manufacturer had twisted his portion one way, and the other manufacturer his portion in a contrary direction. In the first attempt to lay the cable, the machinery invented for the purpose not only turned out defective, but caused the breakage of the cable in the paying-out. In the second attempt to lay it from Valentia to Trinity Bay the cable did not break. Surveys had taken place, and it was shown that the ground in which it was proposed to lay the cable was of a most suitable nature.

Mr. C. Bushell was glad to hear the statement of Mr. Wortley that the directors had not bound themselves to any firm, or to the adoption of any cable, because an impression had gone abroad that Messrs. Glass, Elliott, and Co., had made a very liberal offer—and that impression might be strengthened by the presentation in that room of specimens made by those gentlemen—and that a cable made by them had been selected by the board. He was, therefore, pleased to hear that that was not the case. It was very important, both as regarded the construction and the cost of the cable, that there should be a full and fair competition (hear, hear).

Mr. Wortley replied that the board were not in the slightest manner bound to Messrs. Glass, Elliott, and Co.; and if those gentlemen were directed to manufacture the cable, they would make a very different one to that of which specimens were then exhibited, and one in keeping with the rapid strides of experience. If, however, Messrs. Glass, Elliott, and Co., were selected to make the cable, they would make it in accordance with the directions of the board.

A shareholder remarked that the manufacturers were often hurried on, and not allowed sufficient time for the construction of cables. It sometimes happened that when specifications were issued, parties were not allowed sufficient time to prepare specimens, and thus the competition was limited to those who had specimens on hand. He trusted that when the directors of the present company issued their specifications they would allow sufficient time, and give every one a proper opportunity of being able to compete.

Mr. Wortley said if it was resolved to throw open the manufacture of the cable to wide competition, he would, as far as he could, take care that it was done in the best possible mode, and that, for the sake of the directors as well as their own, the contractors should have the fullest time to manufacture the article in the best possible way they could (applause).

In reply to a question from a gentleman in the room, as to whether Mr. G. P. Bidder (one of the directors of the company) was a member of the firm of Glass, Elliott, and Co.,

Mr. Wortley said that was a very difficult question for him to answer; but so far as he was aware, Mr. Bidder was not a member of the firm alluded to.

Mr. E. Moon also said that he had never heard that such was the case.

Mr. Brocklebank observed that when the enterprise was first started he thought the adventure an exceedingly speculative one. But since that time, great improvements had been made, not only in the manufacture of cables, but in the practice of electricity; and when they looked at what was passing in the Eastern hemisphere. and saw how every day they were being brought nearer to India and China, he thought it would be a great stigma upon them if they did not endeavour to carry out this undertaking (hear, hear, and applause). He must say that the difficulties still to be surmounted were somewhat great, but he was quite willing to take a share in those difficulties by subscribing to this great work (hear, hear). He considered that those who did not lose in the previous undertaking, were in a better position than the old shareholders to take part in the present one; and he called upon the friends of telegraphic communication throughout the world to support the present scheme by every means and influence in their power (hear, hear).

In reply to some observations by a gentleman present,

Mr. Wortley said, since the first attempt to lay the cable, portions of the bottom of the Atlantic had been brought to the surface, and from an examination of these it was believed that the ground was most favourable for the laying of a cable; and he (Mr. Wortley) was not aware of any formations of coral in that portion which the cable would have to cross.

Mr. Job observed that he was acquainted with the coasts of the Atlantic, and he did not believe that coral reefs existed.

Mr. Rankin would subscribe £500 to the undertaking, having every confidence in its value. He would, however, like to see three cables across the Atlantic, for it might happen that if they had only one cable that one might be broken, and the communication be suspended. It was also desirable that the cable should not be made so strong as to render it impossible to coil it in one ship, or so heavy that one ship could not carry it. He was, however, satisfied that the board would give every attention to the subject, and he hoped that the scheme would be successful (hear, hear).

A vote of thanks was then accorded to Sir William Brown for presiding and the proceedings terminated.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para First Quality	... ...	... 2s. 1d. to 2s. 2d. per lb.
Second „	... ...	... 1s. 8d. to 1s. 10d. „
Third „	(Negro Head)	... 1s. 3d. to 1s. 4d. „
Java	... ...	... 1s. 6d. to 1s. 7d. „

GUTTA PERCHA.

Fine, none in the Market worth 2s. 6d. and above.

Genuine Mixed	... ...	... 1s. 9d. to 2s. 0d. per lb.
Reboiled good	... ...	... 1s. 5d. to 1s. 8d. „
Ordinary Reboiled	... ...	... 1s. 0d. „

January 14, 1863.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	62 to 66	
Stock	Electric Telegraph . .	100	98 to 100	
5	London District Telegraph .	all	4 to 3 dis.	
10	Mediterranean Extension Tel.	all	3½ to 4½	
1	Submarine Telegraph, scrip. .	all	⅜ to ⅝	
1	Do. registered . . .	all	⅜ to ⅝	
10	Do. „ . . .	all	4 to 6	
2	Telegraph to India . .	1	¾ to ¼ dis.	
5	United Kingdom Telegraph .	8	¼ dis. to ⅛ pm	

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TELEGRAPH VERSIFICATION.

THE BROKEN HANDLE.

Oh! why art thou broken, poor handle, poor handle,
Like a bough that is torn from the main stem away;
Oh! why did'st thou snap like a penny wax candle,
And leave me in sorrow a shilling to pay.

I much fear 'twas passion that urged to this madness;
I fear that my temper had left for the day;
But oh! 'tis a fact that I mourn o'er in sadness,
I've got for this handle a shilling to pay.

A shilling! yes, earned by the sweat of my body;
A shilling! the fruit of two wearisome hours;
'Twould have paid the expense of a good glass of toddy,
And freshened my mental and bodily powers.

And what was the cause? why, some Manchester booby
Had kindled my wrath with a "Not understand!"
And I, to give vent to my spleen, like a booby,
Shook the handle, which suddenly broke in my hand.

HUGHES.

[These lines refer to a practice which used to be adopted by the Electric Telegraph Company, of making the offender pay one shilling for any Instrument handle wilfully broken.]

Recent Patents.

1581. E. TUCK, *Leadenhall Street, London*, "*Improvements in Electrical Manipulation applicable to Submarine Telegraphs.*" Dated 27th May, 1862.

IN place of the present method of completing circuit through the sea, which has been found so destructive to telegraphic submarine cables, the inventor makes use of the exterior iron wire covering of the cable, to which he affixes a covered conducting wire, which is brought into contact with the interior conducting wire of the cable by the instrument for receiving a message. In conveying or delivering a message this contact is broken, and he makes use of a sheet or piece of zinc (in place of copper) in contact, or placed in the sea, to which is annexed a covered conducting wire, brought into contact with the copper or negative plate of a voltaic battery; this is effected by the recording telegraph instrument as at present in use. Where an electric cable is damaged in its insulation, and the copper conducting wire exposed, to restore or renew communication he makes use of a cylinder or piece of zinc placed in contact with the sea, which has annexed a covered conducting wire brought into contact with an instrument for conveying or delivering a message. Also a piece of copper which is so placed as to be opposed to the zinc (as in a pair of voltaic plates). If a cylinder of zinc be used, the copper is placed within the cylinder, with the ordinary conducting liquid or sea water, as may be requisite. The piece of copper has annexed a covered conducting wire brought into contact with part of the same instrument as the piece or cylinder of zinc. In sending or delivering the message, the wire attached to the zinc cylinder or plate is brought into contact with the exterior iron wire covering of the cable. The wire attached to the piece of copper is brought into contact with the interior conducting wire of the cable. This is effected by means of the recording telegraph instrument fitted with a quantity coil as at present in use.—*Not proceeded with.*

1626. J. GURRIN, *Stroud, Gloucestershire*, "*Telegraphic Communication between Separate Buildings or Parts of Buildings.*" Dated 30th May, 1862.

THIS invention cannot be described without reference to the drawings. —*Not proceeded with.*

1641. A. MOREAU *and* A. E. RAGON, *Bernard Street, Russell Square, London*, "*Electro-magnetic Machines.*" Dated 31st May, 1862.

THIS invention consists in so combining and arranging the several parts of electro-galvanic machines as to be enabled to regulate with facility the intensity of the current, and, further, to keep up a continuous current instead of giving it off by shocks as at present practised. The means by which these improvements may be effected are as follows:—Within a box, of any desired shape, the patentees fix an induction coil, at the centre of which they leave a long cylindrical horizontal opening, in which is laid a bundle of loose iron wires, by increasing or diminishing the number of which the power of the machine is determined. In connection with the above is a glass vessel, containing a mixture of dilute sulphuric acid, and bichromate of potash or other salt. A stopper is fitted to the said glass vessel, and through a hole in the said stopper a rod is passed, and to the said rod a piece of zinc is fixed, which is capable of being raised and lowered between two plates of charcoal fixed to the stopper of said vessel, contact of said plates and piece of zinc being prevented by passing india-rubber bands around the zinc plate. Two flat pieces of metal or conductors rest on the stopper of the glass vessel aforesaid, and communicate with the induction coil of the machine. There is also a trembler or vibrator, which indicates when the machine is charged. Through one side of the box or case of the machine three holes are made, fitted each with a small piece of brass with a hole therein; the two outermost pieces are connected with the positive poles of the induction coil, and the centre piece with the negative pole thereof. In using this machine two small flexible conductors, fitted each with a handle at one end and a small brass pin at the other, are connected to the machine by the pins aforesaid being placed in two of the holes aforesaid in the box. The person to be operated upon, on taking the aforesaid handles one in each hand, will receive the electric fluid from the machine, the operator raising or lowering the zinc plate more or less in the liquid, according to the intensity required, and it is this mode of regulating and governing the intensity of the electro fluid in electro-galvanic machines that constitutes the principal feature in this invention.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

THE PERSIAN GULF CABLE.

To the Editor of THE ELECTRICIAN.

THE prospect of having our Indian news served up with the hot rolls and other steaming aliments of the breakfast table, in some twelve months or so from date hereof, is in the highest degree gratifying, and if the Atlantic Telegraph Company will also have the goodness to supply us with American intelligence, with the same diurnal regularity as that promised by the successful achievement of the work undertaken by the Indian Board, we shall be blest indeed. And then think of the additional incentives to loyalty, the obligations we are placed under, by the successful accomplishment of beneficent projects on the part of a paternal government. Truly we are fortunate people, a nation blest above all others: and then we enjoy such unbounded freedom, that we may even criticise, and that in no measured terms, the very means made use of, and the way of making use of these means, in an enterprise having for its object the good of all, and which, perhaps, is destined to propel the car of civilization forward a whole century in one single year; it is not at all improbable that we may be guilty of this meddling carping criticism (as some people will term it), ere we close this paper. But as it will emanate from no uncharitable motives, but because we have a sincere conviction that in order to attain a certain end, certain means should be used, a lack of which might prove disastrous to the best and most commendably devised schemes, we hope to be met in the same spirit, and no one would regret more than ourselves if anything we might give utterance to should militate, in the slightest degree, against the advancement of that glorious work peculiar to this nineteenth century, the bringing together of the uttermost ends of the earth by means of submarine telegraphy.

But we must not forget that as it is with individuals so is it with nations, an overweening self-confidence is sure to trip, and is doomed to wearily tread the ground over and over again, ere success crowns the efforts which were ever made in too boastful and presumptious a spirit. The western world, north, is no inapt illustration of this at the present hour. The sequel will probably show if we are justified in these remarks, and also whether we have or have not, grounds for not partaking in the sanguine expectations of some people, which seem to border somewhat on the extravagant.

The construction of the Persian Gulf Cable, to which these preliminary remarks have reference, is, I presume, pretty well understood by this time, in all its details, nevertheless, we must risk repetition in order to a critical examination thereof, both as to its structure and also the materials of which it is composed.

The *Times* with its characteristic blow-hot and blow-cold style, devotes the first paragraph of a clever article to the invidious task of bringing submarine telegraphy into disrepute, as though nothing should please it better than the total absence from this field of enterprise of the speculations of private individuals or public companies; and after having instituted a comparison, in extremely bad taste, in which submarine cables are described as pythons, to be gorged with any amount of cash that can be wrung from the luckless shareholders, ere they lapse into utter uselessness,

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the writer then rushes to the other extreme, and would have us believe that the Persian Gulf cable, now in process of manufacture, will be a certain success, a better cable by full 25 per cent. than any other ever made, not excepting the short one of twenty miles destined for the same locality, and manufactured under the immediate supervision of Sir. W. Brooke, who has chosen caoutchouc as the insulator; and this superiority we are to conclude, is due to the fact that the Government, "have not given over this national work to any company, contractor, or concessionaire." But have kept it in their own hands. Once more let us be thankful that we have a government of such vigour, and wide awake enough not to be again taken in by physicians who set up as telegraph engineers, and by sharp companies whose sole object has been to suck like a horse-leech at the public purse. From henceforth the task of writing the history of this nation, so far as appertains to the executive, will be of the most agreeable description, and will commence a new series altogether. The Government is worthy of all commendation in thus showing to the world that they have profited by the expensive experience acquired by their connection with the Red Sea cable, and other similar ventures of disinterested companies; and we do most sincerely trust that their own ventures will be attended with all the success, and more, that prophets in authority prognosticate. But, at the same time, it would ill become us to shut our eyes to the somewhat extraordinary fact, that in this, their first cable, of any consequence, manufactured since their own committee closed their investigations and published their report on submarine telegraphy, that they should have tacitly ignored the conclusions thus arrived at, and have ordered a cable as diametrically opposed to the suggestions therein made as it is possible to be. Had this cable been made six or eight years ago it could not have been of a more antiquated description, nor do we see wherein it differs very materially from any hitherto made, and which, according to the *Times*, have proved such terrible boa constrictors. Notwithstanding this, however, the Persian Gulf cable is to be 25 per cent. better, electrically, then any yet made. This is tall talk Sir Oracle; suppose we examine the grounds for this assertion; we surely have the means of judging, and shall hardly be doing our duty if we allow such statements to pass unchallenged. Let us see if the method of construction really embraces the "recent improvements in the science of telegraphy" as alleged, and in proportion as we find this to be the case, or otherwise, will the superiority as claimed be made manifest, or will it recede from our view as the illusions of a sanguineous and superficial scribbler.

First, there is the conductor; wherein does it differ from that of the Atlantic, the Red Sea, or any other old fashioned cable, save that it is of a larger diameter: it differs in one other respect only—being composed of four segmental wires drawn into one, which, if anything, is rather a disadvantage than not, since if any considerable strain be thrown upon it, or a sudden bend occur at an acute angle, the conductor runs imminent risk of splitting, and the jagged ends will forthwith force their way through the percha; now this is a contingency that could scarcely happen to a solid wire, it might possibly break, but would never split; nevertheless, this segmental quartette is put forth as a vast improvement, not only upon solid, but stranded conductors. We confess to having sought in vain for any sign of improvement here, and even were it equal to a solid conductor, we are just where we were.

We may be allowed to ask why is the stranded form of conductor, as recommended in the Government Report, repudiated? and upon what grounds? Wherein does a segmental solid wire "combine the advantages of a conductor formed of many strands?" And what are the "drawbacks upon this latter mode of construction?" We never heard of but one "drawback," and that to all practical cable manufacturers is more apparent than real; and even were it all that is represented, the "drawback" supposed to exist in the interstices of a stranded wire is easily remedied. The advantages of a stranded conductor are apparent to the most superficial observer: *a*, the strain, if any, is equal upon all the wires; *b*, the continuity can never be interrupted by a break; *c*, the join can be made in each wire forming the strand, separately, at distances from each other, and of such a flexible nature that when the joint is completed, it may be bent and twisted with impunity; *d*, it is as strong and flexible at the joint as at any other part, and will bear an equal amount of breaking strain. True, the joint of a solid conductor, whether drawn segmentally or otherwise, can be made equal in strength to any other part, but this advantage is secured at a dear rate, having to be purchased at the expense of its pliability; the joint must ever remain harsh and brittle, nor could it, without risking the very existence of the cable, be allowed to bend to any greater extent than the arc of a considerable circle.

If, however, the prognostications prove true, and we *have* hit upon an improved method of constructing the conductor, we shall be the first to rejoice; in the meantime, however, we cannot divest ourselves of the disagreeable notion that it is purely gratuitous, and that the questionable policy of trying an experiment upon an important and expensive cable is being persisted in—a course which is indefensible in matters of much smaller moment.

As we proceed we find still less and less grounds for prospectively assuming that this cable will be 25 per cent. in advance of its predecessors. The insulation is gutta percha; it would, of course, be supererogatory to dwell upon the fact that this material, under ordinary circumstances, is only mediocre as an insulator: the superiority of caoutchouc has been demonstrated over and over again, not in theory alone, but in practice If this cable were intended for the Arctic regions, we should—so far as its insulation is concerned, deny that it possessed the smallest claims to superiority; while it would be simply absurd to talk of advantage having been taken of the "recent improvements in the science of telegraphy," inasmuch as the "recent improvements" show that if superiority of insulation is to be had, it must come by the substitution of caoutchouc for gutta percha.

But this cable is for the tropics, or closely contiguous thereto—for a climate which all past experience proves gutta percha to be wholly unfitted for, simply from its utter inability to retain its solidity beyond a certain temperature; and what is the use of the insulation if it will not maintain intact the undivergible centricity of the conductor. Seeing the unfortunate results of gutta percha insulation hitherto in warm climates, we may surely be allowed to express our surprise that it should be again chosen, especially when a better insulator is to be had, which no reasonable temperature will affect. But our surprise and astonishment becomes somewhat increased when we are told that "recent improvements" have been taken advantage of; we have looked in vain for them in the conductor, and the search is equally futile as regards the insulation. A careful examination of the core of this Persian Gulf cable, will convince any competent, unprejudiced judge that the quality of the percha used is not above the average, and he will search in vain for any indication of that pure and unadulterated material of which so much has been said.

The Government Committee urge the adoption of india rubber as the best insulator for submarine cables, and they adduce the most cogent and conclusive reasons why it should be adopted; it is, therefore, to say the least, anomalous that the Government should be the first to set at nought the results of their own labours!

It is by no means a pleasant task to dispel an agreeable illusion, and we are all more or less prone to romance at times, to shut our eyes to hard facts, and to anticipate more from given circumstances than those circumstances warrant. The task is rendered all the more unpleasant because those persons who will persist in this sort of thing are generally most uncharitable towards the matter-of-fact individual who has the hardihood to sweep away the cobwebs of fancy; he is a croaker, a some one interested in the manufacture or sale of leather, and therefore has a prejudice against heart-of-oak and matchless granite. Nor will they allow that he is impartial—that he speaks truth which existent facts bear out, and that the prospect of collapse and failure pains him far more than his accusers: nay, he is even charged with retarding so glorious a work as the development of submarine telegraphy, simply because he takes unwonted pains to point out wherein success lies, and avows his inability to perceive the possibility of success by the use of means which hitherto have been prolific only of failure.

Having vainly sought for the "recent improvements" which are to constitute this a cable *par excellence*, and having also failed in ascertaining the grounds whereon the assumption can be based as to its 25 per cent. superiority, in the regions of its conductor and insulation, it is surely out of the question to look for any indication of these desirable qualities in the outer sheathing, which is simply the old, lumbering, ponderous, spiral, galvanized iron style, stereotyped edition, characteristic of the boa constrictors before mentioned. Why did the Government Committee recommend cables of a light specific gravity, and then set the example of their total rejection? The report objects first to their great weight, and secondly to their speedy destruction by rust. But this latter drawback is to be obviated by the application of Mr. Latimer Clark's Patent, a cure which it is not impossible may prove worse than the disease, since the sensitive percha is in dangerous proximity to the boiling liquid with which the whole is to be enveloped: this is a decidedly novel process, but it can scarcely be said to come under the head of "recent improvements." Evidently the safety of the percha or copper, or both is risked by such an unreasonable weight as from 3 to 4 tons per nautical mile in deep water.

We have an ardent desire for the success of this and all other submarine telegraph projects, and it is because we wish to have cables constructed on unerring principles that we have written the foregoing. If our notions be correct, then it is manifest the cable in question is not constructed upon such principles as warrant the rather extravagant expectations formed of it. That is a misfortune which no one regrets more than we do, and would much rather see our ideas scattered to the winds by actual results, than witness those sanguine anticipations prove

> "As Dead Sea fruits which tempt the eye,
> "But turn to ashes on the lip."

M.

To the Editor of THE ELECTRICIAN.

IN reply to E. S. I may mention that a similar case, that of a circuit working through a broken wire, the ends of which laid on the ground, and were not in contact with the metals of the railway or any other conductor, once occurred to myself—I cannot recollect when or where.

It would be very interesting if your correspondent E. S. would send you the sketch you ask for, as the case could then be fully recorded in your pages.

May I take the opportunity of saying, with reference to Mr. Cook's use of sand as a diaphragm to the Daniell battery, that I tried it a year since

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and did not find it any advantage, and the use of sand has been patented in Italy and elsewhere by M. Minotto, who contributes a very full description of his battery to the September October number of the '*Annales*," p.p. 450 to 464.—Yours truly, R. S. CULLEY.

10 *January*, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—I doubt not but many readers of the ELECTRICIAN would be ready, with myself, to thank Mr. Monney very cordially for his excellent article in your Number for Dec. 5, 1862, on the construction of the induction coil, in which he gives more *practical* information than will be found in many articles of ten times the length. I should feel obliged if Mr. Monney would set me right with regard to one little point in his construction. The iron core is given 17 inches in length, but only 8 inches of it to be covered with the primary wire, and that 8 inches is to have 4 layers. I have understood that the nearer we can bring our wires to the iron core the better, and I could not see the reason why the whole length between the cheeks should not be covered, when possibly two layers would give a better effect inasmuch as the galvanic fluid would be so much nearer the core, and one would suppose the effect would be still greater as it regards the secondary coil. An answer to the above will much oblige,

AN AMATEUR.

Sidmouth, January 9th, 1863.

Telegraphic News.

AN extensive series of experiments is about to be made in France with the typo-telegraph invented by M. Bonelli, by which five hundred dispatches of 25 words each can be printed within an hour. Should the experiments prove satisfactory, it is intended to introduce this telegraph on the principal railway lines in France.

WE hear that Mr. Macintosh has succeeded in covering wires with india rubber under immense pressure, by a process which obviates the necessity of uniting separate portions of material in forming the insulating sheath. The rubber, rendered plastic by pressure, is applied after mastication, by means of steel rollers having semi-circular grooves on their opposite surfaces.

THE Universal Private Telegraph Company have issued a new prospectus in consequence of the board having been strengthened by some Manchester names. About 2,000 of the 7,600 shares of £25 were originally subscribed, and the remainder is now offered to the public. The new prospectus of the Company will be found in our advertising columns.

Miscellanea.

ELECTRIC TELEGRAPHS FOR FAMILIES.—It has been suggested that the electric telegraph is too good a thing to be confined to public use, and that it may be introduced with considerable effect into the domestic circle. It sometimes happens that a husband and wife are, for a time, not upon "speaking terms," though communication between them may be requisite. This desirable result might be easily accomplished by means of the electric telegraph, which should be fitted up in the apartments of every married lady or gentleman. In fact reconciliations would often be much more easily effected by the plan we propose, for there is often something exceedingly provoking in the tone of a voice, while in the sound of the electric telegraph there is nothing whatever to irritate. There should be a station opposite the usual seats of the master and mistress of the house, and short signs could be used, expressive of "When do you mean to get out of your ill-humour?" "I'm ready to make it up, if you are," and other amiable approaches to reconciliation, which could not be so well conveyed by word of mouth as by the mute eloquence of the wire. The sketch furnishes some idea of how the plan could be made to operate, and by which the difficulty of saying "the first word" towards reconciliation may be remedied.—*Punch*.

Mr. J. COCKRANE, of New York, proposes to sink large iron pipes between the forts at the Narrows, in New York harbour, or at other convenient points, from which charges of powder may be exploded under passing ships. The operator is to be *within* the pipe or tunnel, and the powder to be placed at some distance above it, information as to the position of the enemy's ship, being communicated by telegraph. It appears highly probable that the tunnel below, with its enclosed operator, would be destroyed as well as the vessel above. The possibility of firing the powder by electricity, from a considerable distance, and with perfect safety seems to have been overlooked by the inventor.

LUMINOSITY OF THE ATMOSPHERE.—At a recent meeting of the Physical and Mathematical Section of the Manchester Literary and Philosophical Society, Mr. Baxendell, F.R.A.S., mentioned the following observations made by himself and Mr. Richard Dale, on October 24, 1862, at Mr. Worthington's observatory:—The night was remarkably clear. There was no moon, nor any decided indication of aurora in the north; but there was so much light in the atmosphere, that the country around could be distinctly seen, and houses and hedgerows at a distance clearly perceived. This apparent luminosity of the atmosphere continued for two hours, and the night then became very dark, but still remained very clear. Mr. Baxendell afterwards noticed that objects at a distance were seen much more distinctly on this occasion than when the moon was seven days old.

POROUS VESSELS, such as are used in the construction of batteries, have recently been used by M. E. Guignet in the operation of dialysis, in which these vessels advantageously replace parchment paper. M. Guignet states that he placed a porous vessel, filled with pure water, in a mixed solution of gum and sugar. At the end of twenty-four hours, a great part of the sugar had traversed the porous vessel, and passed into the water; while no trace of gum had passed from the external vessel. An ammonio-cupric solution of copper was also submitted to the dialysing medium; the copper salt traversed the porous vessel, while the cotton remained in the outer liquid.

TELEGRAPH EXPEDITION.—The Emperor's speech on the opening of the French Chambers was transmitted from Paris to London in twenty minutes by the Submarine Telegraph Company. Four wires were simultaneously employed in the transmission. The speech consisted of nearly 1360 words, or 6800 letters, so that each wire had to transmit 340 words, or 1700 letters in the twenty minutes occupied.

TELEGRAPHING BY THE LIME LIGHT.—Captain Bolton has successfully telegraphed during a hazy night from Portsmouth to Fort Bembridge, on the Isle of Wight, a distance of thirteen miles. The signals are flashes of the lime light, the times of the exhibition being regulated much as in the Morse Telegraph Code, so as to correspond to an alphabet agreed upon. This mode of telegraphing is likely to be of great service in time of war.

LIGHTING STREETS BY PHOSPHORESCENCE.—I have alluded to the fact that houses freshly painted with limewash are frequently luminous at night, though slightly, after exposures to the sun's rays during the day. If by chemical and physical researches a means were discovered capable of rendering this phosphorous light more powerful, by employing sulphides of calcium, or barium, &c., and superadding, if necessary, the action of any electric current when the sun is hidden by clouds, a street might be effectively illuminated by phosphorescent light alone.—*Phipson on Phosphorescence*.

WHEN a succession of electrical sparks is passed through ammoniacal gas, it is resolved into its elements, and the same effect is produced by conducting ammonia through porcelain tubes heated to redness. Berthollet thus found, that 200 volumes of ammonia occupied the space of 400 volumes, 300 of which were hydrogen and 100 nitrogen, and the same has since been verified by Dr. Henry.

To Correspondents.

J. L. wishes us to put the following question to our readers:—"Can it be proved that in all cases the messages are actually transmitted by the artificial conductor provided?" and our correspondent further adds:—"I believe this question cannot be conscientiously answered in the affirmative, especially where earth plates are used."

HONORARY.—We have seen and examined a specimen of the core adopted by the Indian Government for the Persian Gulf Telegraph. We shall, upon a future occasion, express our opinion as to its merits.

INQUISITIVE.—We have received several letters with reference to Mr. Haworth's patents. The specification can be obtained at the Patent Office, Southampton Buildings. Mr. Haworth states that he has perfectly succeeded in transmitting signals between London and Kingstown, in Ireland, without the aid of a metallic conductor; but, as far as we know, the statement rests entirely upon his own authority.

TIMID.—Some of the wires of the London District Telegraph Company, it is true, have fallen, but without much injury to person or property. Improvements are daily being effected in the over-house system of telegraphy, and it is to be hoped that these accidents will be avoided. The advantages derived from the system vastly exceed the disasters which have hitherto occurred.

A SUBSCRIBER.—The office of the United Kingdom Telegraph Company is in Gresham House, City. W. P. Andrews, Esq., is the Engineer.

ERRATA.

Page 109, line 13, for "indicative," read *inductive*.

Page 110, line 10, for "its own ratio," read *the ratio of its own square roots*.

Page 110, line 38, for "tension," read "*torsion*,"

*** All Letters, Works for Review, and other Communications for the Editor, should be addressed to the Office, 32, PATERNOSTER ROW, LONDON.

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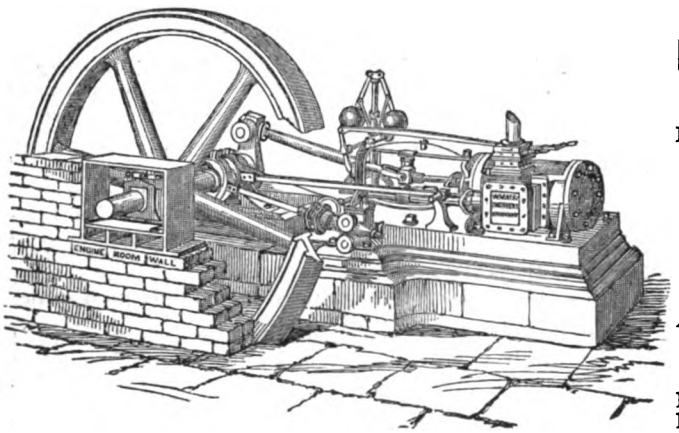

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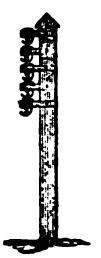

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The Electrician.

VOL. III. No. 64.—JANUARY 23, 1863.

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THE "EARTH," AS PART OF A VOLTAIC CIRCUIT.

THE case, communicated by "E. S." and corroborated by Mr. R. S. CULLEY, of a telegraphic circuit being worked through a broken wire, the ends of which were in contact with earth, appears in some quarters to have been taken in confirmation of the notion that electric signals may be transmitted to any required distance without the use of a metallic conductor. It may be necessary, therefore, to point out that this supposed confirmation has no existence in fact. There are no grounds whatever for supposing that any case similar to those which have been noticed by our correspondents, is not susceptible of being readily explained in accordance with the known laws of electrical science. It is altogether different when we come to the practical problem of signalling by electricity without a conducting wire. If we have hitherto been silent in regard to this question, which seems to have latterly engaged some amount of public attention, it is that the means proposed for its solution are, to us, simply incomprehensible. We cannot dispute their efficiency, since we are forced to admit that we cannot perceive upon what principle efficiency is aimed at. If not greatly beneath, the proposed system must therefore, of necessity, be considerably beyond any critical examination on our part. While, in such case, it would clearly be unjustifiable to deny without disproving, or to use the word "impossible" in reference to what has been put forward as an accomplished fact, the only alternative is to await, "with modest scepticism," the verification and elucidation of the "fact" thus asserted.

To render intelligible the phenomenon observed in the broken wire circuit, we must have recourse to the law of derived currents. Divested of all technicality, this is simply that, when several conducting paths are offered for the passage of a current, the quantity of electricity traversing in each path respectively will be inversely proportionate to its resistance. If, therefore, in this instance, the resistance between the broken extremities of the wire, added to the resistance of the wire from the point of rupture to the "line" earth plate, *plus* the resistance between the two earth plates, be less than the resistance between the broken portion of the wire, in contact with earth, and the battery earth plate; the quantity of electricity traversing the signalling instrument at the distant station cannot be reduced to the extent of one-half the normal signalling power. Under these circumstances, therefore, signals might be received almost as usual. Provided that the earth connections of the main circuit were very perfect, and the point of rupture nearer to the receiving than to the sending station, or that the broken ends of wire were resting upon ground freshly moistened by rain and covering a dry substratum, it is quite possible that the signals would not be very perceptibly reduced. We need scarcely observe that, if the broken ends were immersed in a tank of water insulated from earth, no current of derivation would occur, and the signalling current would be weakened only by the additional fluid resistance.

In its more extended application, the simple and well-established law of derived currents is of extreme importance in explanation of many of the phenomena observed in telegraphic circuits. It has long been a point of discussion, whether, in such circuits, the earth actually takes the part of a conductor, or whether it does not act as an immense reservoir, neutralizing the opposite tensions produced by the battery, without being subject to continuous electrolysis—apparently involving the idea of very great resistance, between the earth plates. By applying in this case the principle above referred to, it will be seen that the question is merely one of terms imperfectly understood. A conductor of such infinite extent, or series of conductors so infinite in number, as in the aggregate to offer no appreciable resistance, may be regarded as an immense "reservoir" of electricity. What may be termed the main or direct current, traversing through earth from one to the other earth contact, is that in the path of least resistance, *i.e.*, in the section of fluid immediately between the plates. But the electricity traverses also an infinite number of paths of greater resistance, in accordance with the law of "derived currents;" and the quantity of electricity in the main current, as well as in any determinate path of derivation, being thus almost infinitely small, the total resistance of the earth portion of the circuit may, under conditions which are well understood in practice, become quite inappreciable.

That the earth actually conducts the return current may be proved experimentally by interposing plates of metal, connected by wire, between the earth plates in a telegraph circuit. It is necessary, however, in this experiment, to bear in mind the conditions above referred to, the actual prevalence of which thus becomes also experimentally verified. If the circuit be very short, the interposed plates much larger than the earth plates and in close proximity to the latter, and if the wire resistance (including galvanometer) between the interposed plates be inconsiderable, the quantity of electricity thus intercepted will be proportionately great. Even if the circuit be of moderate length, and the wire resistance between the interposed plates proportionately great, we may obtain an indication upon the galvanometer of the electricity intercepted in the return current. As we increase the length of the circuit, however, this indication becomes gradually weaker, although we may preserve the same amount of resistance in the wire uniting the interposed plates. This phenomenon requires explanation; which may be found by a careful consideration of the conditions involved in the earth conduction of the return current. It is to be observed that as the distance between the plates is augmented, the resistance encountered by the "main" or direct current between them is obviously increased. This fact, taken alone, would not account for the diminution in the quantity of electricity intercepted by our interposed plates, provided the metallic resistance between the latter be maintained constant. But, at the same time, the resistance, never absolutely *nil*, which is opposed to the indirect or "derived" currents in the aggregate, is actually diminished, and the diminution of resistance in this case bears a higher ratio to the increased distance than does the increase of resistance in the direct path of the current. The latter fact is susceptible of experimental illustration; but may perhaps receive elucidation from some of our mathematical readers. It indicates that the total resistance to earth conduction, in a circuit of which the earth forms one half, may be greater with a distance between the earth plates of a few inches or yards than with a distance of some miles or hundreds of miles. The reason of the diminished indication upon the galvanometer in the above experiment, when the distance between the earth plates is augmented, is thus rendered evident; the wire resistance between the interposed plates, although in itself constant, becoming greater in proportion to the aggregate resistances in the other paths of the return current.

We pass over some other experiments of interest in connection with earth conduction, in order to make out the best case possible for those who believe in the present practicability of signalling,

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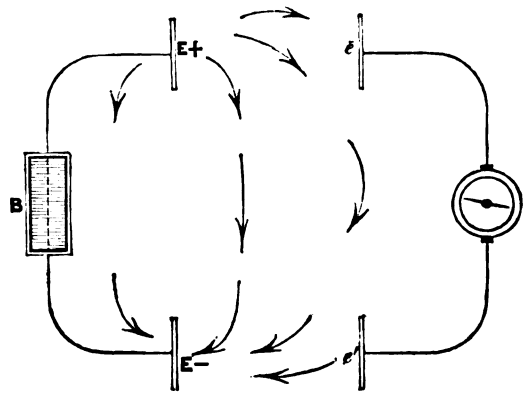
by means of voltaic electricity, without any insulation between the two halves of the circuit. Instead of placing our interposed plates in a direct line between the earth plates in a circuit, let us arrange them in a path which must be traversed by an indirect or derived current, as in the following figure, in which B is the battery, E+ and E— the two earth plates, and *e e'* the two interposed plates.



At whatever distance the two systems may be placed apart, a current will undoubtedly traverse the galvanometer between the plates *e e'*, whenever the circuit of the battery is completed. We make the admission unreservedly, from the point of view of theory; the practical deductions to be drawn from it have yet to be considered. We have to calculate the force of the current which may traverse from *e* to *e'* through the galvanometer or receiving instrument, or, in other words, the proportionate quantity of electricity taking this path, compared with the total dynamic effect of the battery.

Now we have reason to believe that something like the following plausible method of arriving at a conclusion upon this point is adopted by some of the more advanced among those who hold the untenable view above referred to :—

"Let the wire and battery resistance in the 'transmitting system, E+, B, E—, equal 1000 units;

"The resistance of the receiving system *e e'*, equal 100 units;

"And let the resistance between the earth plates E+ and E—, and between E+ and *e*, and E— and *e'*, be inappreciable.

"Then the resistance in the direct circuit completed by the battery plates E+ and E— will equal 1000.

"And the total resistance in the indirect circuit through *e e'*, will equal 1100 units.

"And, by the law of derived currents, if the force of the current traversing the direct circuit be represented by 1100, that of the current traversing *e e'* will be 1000."

It will be scarcely necessary for us to point out the fallacy of this mode of reasoning. It assumes the existence of two paths only for the return currents—the path of least resistance between E+ and E—, and that through *e e'*. But it will readily be seen that the earth affords a multitude of paths of conduction for the earth portion of the circuit, of which that from *e* to *e' is one*. The latter is therefore included in the resistance between the earth plates E+ and E— specified as inappreciable. As this *inappreciable* resistance is to the resistance of wire from *e* to *e'*, so will be the relative force of the currents traversing the transmitting and receiving systems respectively. The ratio, in a circuit, without metallic conduction of moderate length, approximates to that of infinitely great to infinitely small. Can any practical system be based upon these data?

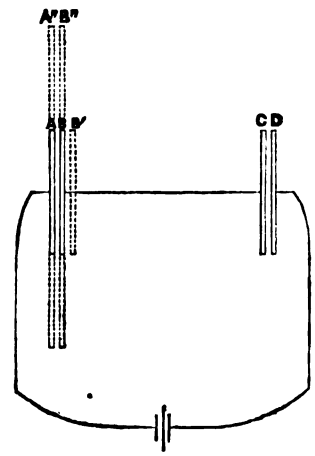
SOME CONSIDERATIONS ON THE PRINCIPLES OF ELECTRICAL CONDUCTION AND ACCUMULATION.

BY F. C. WEBB, ASSOC. I.C.E.

[Continued from page 304, vol. ii.]

IF the electrometers E' and E'' did not exist in the system, this case would be similar to that represented in fig. 49 A, page 89 (Part I.).* In that instance we did not investigate the alteration in tension, because, for reasons which have been fully explained, I avoided the use of the term "tension" until I could carefully define it. The alteration in the tension of each pole caused by altering the plates A and B, can, however, easily be found in such case by simply applying, when the quantities and resistances are found, the equation T=Q R, or, in fact, by multiplying in

Fig. 49 A.



each case the quantity on any surface by the inductive resistance separating that surface from its opposing surface, and taking those surfaces connected to earth as our datum of reference.

I will now give examples of this, when the resistances between the plates A and B are altered in three different ways, viz.: first, by keeping the size of all the plates constant, and altering the distance between A and B; secondly, by maintaining the distance between the plates constant, and increasing the surface of A and B; thirdly, by increasing the distance between and the surface of the plates A and B in the same ratio.

These examples will show generally, and I believe clearly, the relations between resistance, quantity, surface, density, and tension.

Suppose, therefore, the plates A and D connected respectively to the positive and negative poles of the source, and let the plates C and B be supposed connected to earth. Then, from what has been said, A would have a positive tension, and D a negative tension, and C and D would have no tension. Let the plates all be of equal sizes, and let the distance between A and B equal that between C and D.

Let a unit of tension be a unit of quantity, on a surface separated by a unit of resistance (or a resistance having a unit of area and unit of length), from its opposing surface.

Let a unit of density be a unit of quantity on a unit of surface.

Let *l*, the distance between the plates, or length of the resistance, equal two units of length.

Let S, the surface of each plate, = 50 units of surface, then will:

$$r, \text{ resistance between A and B}, = \frac{2}{50} = 0{\cdot}04,$$

$$\text{and } r, \text{ resistance between C and D}, = \frac{2}{50} = 0{\cdot}04.$$

* Lately published in a separate form.

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And the resistance of the whole circuit will be expressed by

$$R = r + r' = 0\,08.$$

Let Q, the quantity generated on either side of the source, when the resistance of the circuit is R, equal 100 units of quantity.

Then T the tension of A $= Q\,r = 4{\cdot}00$ positive,

and t „ „ of D $= Q\,r' = 4{\cdot}00$ negative,

and D density on A $= \frac{Q}{S} = 2{\cdot}00$,

and d „ „ D $= \frac{Q}{S} = 2{\cdot}00$,

Let now the plate B be separated to B′, so that the distance between A and B is m times that which previously existed. Then if m equals 3,

$$R' = m\,r + r' = 0{\cdot}12 + 0{\cdot}04 = 0{\cdot}16,$$

$$\text{and } Q' = \frac{Q\,R}{R'} = \frac{100 \times 0{\cdot}08}{0{\cdot}16} = 50.$$

And the tensions are now—

$$T = Q\,m\,r = 8{\cdot}0 +$$

$$\text{and } t = Q\,r \quad - 2{\cdot}0 -$$

$$D' = \frac{Q'}{S} = \frac{50}{50} = 1,$$

$$d' = \frac{Q'}{S} = \frac{50}{50} = 1.$$

We see here, that although the tensions on each side of the source have become unequal, the densities remain equal, although they have both decreased.

Suppose now, instead of increasing the distance between the plates A and B, we increase their surface m times to A″ and B″, then

$$R' = \frac{r}{m} \times r' = \frac{0{\cdot}04}{3} \times 0{\cdot}04 = 0{\cdot}0533,$$

$$\text{and } Q' = \frac{Q\,R}{R'} = \frac{100 \times 0{\cdot}08}{0{\cdot}0533} = 150,$$

$$T' = Q'\frac{r}{m} = 1{\cdot}995 \text{ (or } 2{\cdot}00,$$

$$t = Q'\,r' = 6{\cdot}00,$$

$$\text{and } D' = \frac{Q'}{m\,S} = \frac{150}{3 \times 50} = 1{\cdot}0,$$

$$d = \frac{Q'}{S} = \frac{150}{50} = 3{\cdot}0.$$

Here the tensions are to one another as the densities.

Suppose now the plates A and B are separated m times, and increased in surface m times.

Then

$$R' = \frac{m\,r}{m} \times r' = r \times r' = R = 0{\cdot}08.$$

Consequently $Q' = Q$,

Therefore, $T' = Q\,r = T$,

and $t' = Q\,r' = t$,

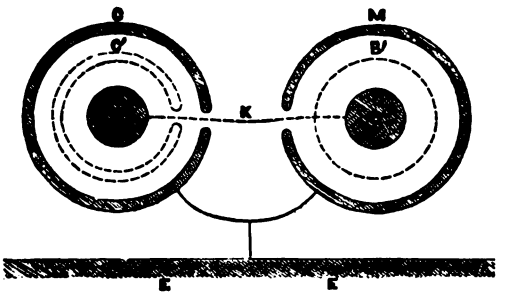
or the tensions are the same as before the plates A and B were increased and separated. And

$$D' = \frac{Q}{m\,S} = \frac{100}{3 \times 50} = 0{\cdot}66,$$

$$d' = \frac{Q}{S} = \frac{100}{50} = 2{\cdot}00.$$

Here, therefore, is an example where the resistances, quantity and tensions, remain unaltered, but the density on the plate A is altered, whilst that on the other plate, D, is not altered.

Fig. 98.



Before closing this chapter, it will be well to give a final example of the relations between quantity, inductive resistance, surface, density, and tension.

Suppose A and B two equal and similar conductors, surrounded concentrically by equal conducting shells C and M connected to earth.

Let Q = quantity on A,
Q′ = „ „ B,
R = inductive resistance between A and C,
R′ = „ „ „ B and M,
S = surface of A,
S′ = „ „ B,
T = tension of A (*i. e.* tension existing between A and earth),
T′ = tension of B,
D = density on A,
D′ = density on M.

Then, if the spheres be joined by a wire K, and a quantity communicated to them in any way, since R = R′, Q will also equal Q′, and T, or R Q will equal R′ Q′. And since their surfaces are also equal, their densities are also equal.

Suppose now the connecting wire removed, and suppose shell C be contracted round A, so that R is now less than R′. Then since Q = Q′ and R is less than R′, R Q is less than R′ Q′, or in fact T is less than T′, and if the two conductors were now joined electricity would flow from B to A. As the surfaces, however, are equal, and the quantities still equal, the densities are still equal. We see here an example of two conductors of the same size, having the same quantity, and consequently the same densities, but having unequal tensions.

Suppose now the conductor B increased within its shell to B′ to such an extent that R again equals R′. Then since the quantities are still equal, and the resistances equal, Q R = Q′ R; or the tensions are again equal; but as the surface of B is greater than that of A, and the quantities are still equal, the density on A will be greater than that on B. Here the resistances, quantities, and tensions are equal, and the densities unequal.

Suppose now the shell C still further contracted round A, then since R would be less than R′, Q R would be less than Q′ R′, or the tension of A would be less than that of B, but the density on A is still greater than that on B. Here the quantities are equal, but the tensions, surfaces, and densities unequal, and the conductor having the least tension having the greatest density, and *vice versâ*.

Suppose, now, the shell C is increased to its former size, then R will be greater than R′, and consequently Q R is greater than Q′ R′, or T is greater than T′; but the density on A is still greater than that on B. Here, therefore, the quantities are equal, but the tensions, and surfaces, and densities, unequal, and the conductor having the greatest tension has also the greatest density.

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Suppose, now, the conductors joined by a conductor, then a quantity will pass from A to B, so that Q R will equal Q′ R′, or, in fact, so that T = T′. We cannot tell now, without more definite information as to the resistances and surfaces, &c., on which conductor will be the greatest density; but if now the connecting wire is withdrawn, and afterwards the conductor B reduced to its former size, then, since the conductors are equal, and their shells are also now equal, the resistances are equal, but since the quantity on B is greater than that on A, Q′ R′ is greater than Q R, or the tension of B is greater than that of A, and, as the surfaces are equal and the quantity on A greater than that on B, the density on A is greater than that on A′. Here we have an example where the resistances and surfaces are equal, but the tensions, quantities, and densities unequal. And in this case, since the resistances are equal, T is proportional to Q, and since also the surfaces are equal, D is also proportional to Q.

If, now, the shell C is reduced sufficiently, so that R Q shall be equal to R′ Q′, the tension T will be equal to T′, but since Q is less than Q′, and the surfaces are equal, D is less than D′. Here the tensions and surfaces are equal, but the resistances, quantities, and densities unequal. If, now, the shell C is still further reduced, so that R Q is less than R′ Q′, the tension of B will become greater than that of A, but the density of B will become greater than that of A. Here, therefore, the surfaces alone are equal, and the quantities, tensions, and densities unequal; the conductor having the greatest tension having also the greatest density.

To sum up, for easy reference, the relations between all these elements of problems of electrostatics,—

Let Q = quantity,
R = inductive resistance,
S = surface,
D = density,
T = tension.

Then:

$$1.\ D = \frac{Q}{S},$$

$$2.\ Q = S\,D,$$

$$3.\ S = \frac{Q}{D},$$

$$4.\ T = Q\,R,$$

$$5.\ Q = \frac{T}{R},$$

$$6.\ T = D\,S\,R,$$

$$7.\ R = \frac{T}{Q},$$

$$8.\ S = \frac{T}{D\,R}.$$

To give a few easy illustrations of these formulæ—

Suppose we have a mile length of submerged telegraph cable charged with a certain quantity, Q, call this quantity unity, the inductive resistance of the gutta percha covering unity, the surface of the copper wire unity, and the density of the electricity on the surface of the copper wires unity.

Suppose, now, this charged cable connected to a similar cable of the same length.

Then, since Q is unaltered, but the surface of the copper wire doubled, we have by equation 1

$$D = \frac{1}{2} = 0{\cdot}5$$

or the mean density is reduced to one-half, and, since in this case every fraction of surface is separated by an equal inductive resistance from its opposing surface, and thus the density is uniform throughout, the density at every part is reduced to one half its previous amount. Now, since the length of the cable has been doubled, the inductive resistance is halved, and since the quantity is the same, then by equation 4,

$$T = 1 \times 0{\cdot}5 = 0{\cdot}5,$$

or the tension is halved.

Suppose, now, that without altering the quantity, we could increase the thickness of the gutta percha, to such an extent on the whole two mile length as to double the inductive resistance, then since R again = 1,

$$T = 1 \times 1 = 1,$$

or the tension is again as at first. As the quantity and the surface of the copper wires are unaltered, however, the density is still 0 5.

Suppose, now, with the single mile length, as at first, we find, by a test for tension, that the tension has been doubled; then by equation 5, since R is 1,

$$Q = \frac{2}{1} = 2,$$

or the quantity is doubled.

And again, if we found the tension halved, knowing at the same time that R was unaltered, we have

$$Q = \frac{0{\cdot}5}{1} = 0{\cdot}5.$$

Suppose, now, on a two mile length of similar cable, we found T = 1, then since R = 0·5

$$Q = \frac{1}{0{\cdot}5} = 2.$$

Again, if with the single length, when we knew the quantity was constant, we found T = 0·5, then by equation 7 we have

$$R = \frac{1}{0{\cdot}5} = 0{\cdot}5,$$

if, therefore, we knew that R could only have been reduced by increase of length, we should know the length of cable was doubled; or supposing the length constant, we should know that the thickness of the gutta percha coating was greater, or that if the thickness and length are both constant, we should know that the specific inductive resistance of the insulation had been doubled.

Suppose, now, we have two, or more, conducting surfaces, having the same tension throughout, or, in fact, charged surfaces in equilibrium; and suppose, further, that every part of these surfaces are separated equally from a surrounding surface. Then, since T and R are constant over every part of the surfaces, by equation 9, D must be constant over each of them. If we could test this density at any one part, then, by equation 2, we should obtain the quantity respectively on each. Thus, if on a surface of 1 we have a density of 1, and call the quantity of that charge 1, then, if on a surface of 3 times the area we find a density of 4, by equation 2, we have—

$$Q = 3 \times 4 = 12.$$

Again, suppose we have other surfaces so situated as to have equal conductive resistance of each portion of them; then, if we could obtain a measure of the density, and then a measure of the quantity, we could obtain, by equation 3, their relative surface. Thus, if one have a density of 3 and quantity of 5,

$$S = \frac{5}{3} = 1{\cdot}666.$$

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Again, if we know the inductive resistance, density, and surface, we can obtain the tension by equation 6. Thus, if a charged conductor, separated uniformly by a given inductive resistance from a surrounding surface—and call the density, quantity, and surface of this conductor all unity—then, if we have another conductor of different size, whose surface is 3, and separated also, uniformly, by a known resistance = 6, then, by testing the density, and multiplying by the surface and resistance, we obtain the tension. Thus, if the density is 2,

$$T = 2 \times 3 \times 6 = 12.$$

Again, if we could test the tension, density, and inductive resistance of a conductor, we could obtain its surface by equation 8; this is a case, however, which could hardly occur in practice. The equalisers, 2, 3, 5, 6, 7, 8, are, it will easily be seen, derived from the equations 1 and 2, viz., $D = \frac{Q}{S}$ and $T = Q\ R$, and would be obvious to anyone considering the subject. The expression $T = Q\ R$ gives a perfectly definite sense to the term tension, so far as regards all cases of conductors separated from one another by conducting surfaces, in conductive connection, to which the tension of the conductors is referred already. And, indeed, I believe this expression will be found very useful, as it is applicable, in nearly every case that can possibly occur, in problems relating to submarine telegraphs. *

THE SURVEY OF THE ATLANTIC SEA-BED.

(From the *Morning Herald.*)

PRACTICAL men are too apt to deride scientific speculations and those who propound them. When Denon and his learned associates, mounted on grave Arab donkeys, accompanied the army of Egypt on its campaigns, the wags of the regiments used to shout aloud, as the dangers of an attack or rude *melee* presented themselves, "Faites place pour les savans et les demi-savans." To the soldiers with the task of conquest before them the troupe of archæologists was simply an obstruction and useless hindrance. And we should almost be inclined to think that the last meeting of the Royal Geographical Society is likely to be esteemed by the commercial and enterprising gentlemen who are reviving the scheme for the Atlantic Telegraph in no better light. We are sure that Dr. Wallich, who insists that our present amount and kind of information regarding the deep sea-bed of the Atlantic are inadequate "to meet the requirements of oceanic telegraphy," will excuse the business promoters of this means of communication between the two hemispheres if they regard such objections as rather ill-timed, and apt to invite a very harmful delay. And we are bound to allow that the great question of uniting Europe and America by telegraph demands a readier solution than the physical geographers have ever seemed likely to afford it, nor should we be surprised if the worthy disquisitionists who gave their crotchets, objections, and apprehensions, an airing last Monday evening, found that long before they have satisfactorily assured themselves of the character of the "ocean bed" of the Atlantic the cable will be in working order—nay, may even be used to convey to their brethren in America the accurate diagnosis of the soundings of the 1300 miles of sea, which are not at present performed.

Perhaps, however, our readers would like to know what was the subject discussed. Dr. Wallich, who has achieved an European reputation, proposed that "a trustworthy telegraphic survey, which should determine the geological character of the entire sea-bed stretching from Galway to Newfoundland, should be undertaken. The learned gentleman's objects for such an enterprise were in the highest degree praiseworthy, as far as the due pursuit of knowledge is concerned, but are, we are afraid, merely a stumbling block to the progress and adoption of the Atlantic Telegraph. He recommended that the Government should fit out two steam ships, with the novel arrangement of dispatching the vessels "in two parallel courses, removed only two miles from each other," and that the soundings should be taken alternately on "each line of the longitudinal belt thus defined." While, therefore, urged the doctor, there would be an interval of five miles at the utmost between any two soundings on the same line (that was, taken by the same ship), there would be an interval of only two-and-a-half miles between those on alternate lines! All very precise, but rather tedious and troublesome work, we should fancy. Doubtful and dangerous areas, the doctor advised, should be minutely inspected, and the line of soundings taken in 1857 by Captain Dayman, on board her Majesty's ship *Cyclops*, was to form the base of operations, and be accepted as the centre of the two-mile longitudinal belt. The task might, as the doctor estimated, be accomplished in six months, and it would furnish no less than 640 reliable observations across the entire deep water of the Atlantic. It was well that this fairseeming fallacy was knocked on the head by Sir Edward Belcher, who is a shrewd old sailor, with, perhaps, greater and sounder experience of the labours and trials of marine surveying than any other man in the assembly over which Sir Roderick Murchison presided. Sir Edward instanced the unsatisfactory search for shoals which he had gone through, "even within 100 yards of his own ship, for six weeks at a stretch, working fourteen hours a day," and cited the difficulty of "finding a rock which did not cover a much larger space than their president's chair." In Sir Edward's opinion Dr. Wallich's pretty little scientific essay would take sixty years to complete it, "and by that time the doctor himself would not be able to profit by his proposal." The suggestions advanced by Sir Edward in the course of his remarks were much more simple and capable of being turned to account by the best friends of the Atlantic telegraph. "They did not want," affirmed Sir Edward, "the deepest water for the laying of a Transatlantic telegraphic cable." "If they carried the line from the Hebrides or the Orkneys to the Faroe Islands, and so on in that direction, they would have a simple method of being sure of what they were doing." This is advice worth discussing. And before he sat down this very practical counsellor threw out a hint that it would "be better to take the opinions of scientific men as to whether it would not be right to have four separate stations for the telegraph across the Atlantic, instead of adopting the plan of crossing by one long line." Admiral Elliott followed on the same side, and expressed his entire faith in the possibility of laying a light cable from shore to shore so as to establish the communication between England and America within the next twelve months.

It should be remembered that this opinion is borne out by the careful and recorded experience of the officer in command of the *Porcupine*, surveying vessel, employed by permission of the Admiralty, on a deep-sea sounding cruise on the west of Ireland. This officer, Mr. Hoskyn, R.N., expressed his confidenee that the lighter the cable was the better, so that it had but specific gravity enough to sink it. He pooh poohed the chimerical objections about the strain to which it would be subjected from counter-currents, insisting that "our larger experience has taught us that these, like the precipice, are imaginary dangers, and that, in the part of the ocean the cable will cross there are even no surface currents that will injuriously affect it, these appearing to be more of a surface drift, whose direction and strength depend on the prevailing wind." A cable with a core of 5 cwt. of copper to the mile, coated with gutta percha, having a breaking strain of 7 cwt., is thought to be "all that is necessary for its safe descent to the bottom. And if the bed of the ocean is free from volcanic action," as it certainly appears to be between Ireland and Newfoundland, "I know of no other force," writes this gentleman, "that would be likely to injure the cable."

We have more than once suggested the propriety of abiding by Mr. Hoskyn's report to those who are most prominent in this renewed attempt to link the English and American shores in electric connection. No attempt has been made to question the data he has obtained and presented, and the best test of the reality and value of his communications is the readiness with which the contractors have agreed to take so large a venture as a cash subscription of £25,000 in the promotion of the undertaking.

Under any circumstances the directors of the new Atlantic Telegraph Company would not be justified in abiding by Dr. Wallich's plan for mapping out and describing every yard of ground on which the cable may have to rest; and had Messrs. Glass, Elliott, and Co. been obliged to furnish such specifications in the submarine telegraph enterprises which they have already accomplished, we do not fancy that those gentlemen, in the eight years of their recorded successes, could have laid down the thirty cables, extending to 6749 statute miles of insulated wire, to which they at present point with honourable ostentation.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

December 11th, 1862.

ON ELECTRICITY AS APPLIED TO CLOCKS.*

BY MR. C. G. GUMPEL, MECHANICAL ENGINEER.

THE author introduced his subject with a short sketch of the history of the practical application of electro-magnetism, in special relation to time-keepers, beginning with Gouss and Weber, who established, in the year 1833, a telegraph in Gottingen, which, although only intended for experiments on a grand scale, naturally suggested the possibility of telegraphing letters, words, and whole sentences; while it afforded also the means of sending (*i.e.*, telegraphing) the correct

* This relation between tension, quantity, and inductive resistance, is only applicable in those cases where the conductors are each surrounded by conducting surfaces connected together, and have no separately charged conductors between the conductors and these surrounding surfaces; the tension experienced being that existing between the conductors and the surrounding surface. If these external surfaces are connected to earth, the tension expresses that existing between the conductors and the earth. (See also previous paragraphs on this subject.)

* For the illustrations to this paper we are indebted to the courtesy of the editor and proprietors of the *Engineer*.

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time from the observatory for the regulation of clocks. After this undoubtedly first attempt of applying electricity for horological purposes, the author referred to Steinheil's improvement in making the electric current itself the corrector, instead of leaving it to the observer to do. This was the first self-acting apparatus, executed at Munich, in 1839. The next improvement was Professor Wheatstone's, in making the electric current the motive power for a certain number of secondary clocks, the current itself being regulated by an ordinary clock driven by weights. Next came Bain, who made electro-magnetism the primary moving power, in lieu of weights and springs. The author then alluded to the enticing idea of making a clock which does not require winding, as having led to the many attempts at producing electric clocks, in most of which the main object of keeping correct time was sacrificed to the above. The real cause of the not more frequent application of electric clocks the author declared due to the capricious nature and unreliableness of the moving force, *i.e.*, the galvanic battery; and he divided his subject, treating first on the forms of batteries employed, and secondly, on the mechanism for producing a proximate perfect time-keeper.

In speaking of the source of electricity, the author mentioned the rapidity with which the battery power decreased, as well as the constant attention required to maintain a supply of power. He considered the following as necessary conditions for a galvanic battery for horological purposes:—

1. Constancy of action for at least a fortnight without being seen to; for at least a month without being recharged, and for three months without being renewed; with a certainty of supply of sufficient power.

2. Simplicity in its construction, so that the least initiated may arrange it, clean it, &c. &c.

3. Freedom from noxious vapours, and cleanliness in being handled about.

As strong elements, such as Bunsen's "carbon" and Grove's "platinum," were usually those which decreased quickest in power, they were least applicable, as also objectionable in consequence of being neither simple in their construction nor free from noxious vapours. The author spoke very favourably of Daniell's battery, and gave some extracts from a report of its application for moving a number of public and private clocks at Leipsic, in which city about fifty clocks were supplied once every minute with the current from a battery of about twelve elements. This battery was cleaned every month, one of the elements after another being removed and replaced by a clean one during the interval when the current was not required. The diaphragms or porous cells consist of hose piping, and not clay. The same cells had then, (1854) been used for three years, and were expected to last still the same period, as the zinc was immersed in a solution of alum. The constancy of this form of battery is very highly spoken of, and, although more complicate than desirable, it possesses the great advantage of containing no acid.

After mentioning Mr. Mullins's "self-sustaining battery," and pointing out its evil, and the difficulty of obtaining good wooden diaphragms (of which the author showed a specimen he had used for some time), he proceeded to point out the advantages and disadvantages of Smee's battery, referring to Mr. Shepherd's experience as stated in a paper read before the Society of Arts.

The next form of battery alluded to was the so-called earth-battery, deriving its origin from Steinheil's discovery that the earth could be employed as a conductor for the return current; while Gauss, in carrying out this plan, immersed at one end of the wire a zinc, and at the other a copper plate (whether accidentally or designedly the author could not state) into the ground, when a strong galvanic current was found passing through the wire. Bain was the first to apply this to horological purposes, and, according to his statement, such a battery supplies a comparatively weak but constant current. Mr. John Inshaw, engineer, of Birmingham, assured the author that he had kept an electric clock going for several years by means of an earth battery, without ever once paying attention to it.

In Vienna, a seconds pendulum, weighing 6 lb., was kept going for a period of one year and nine months by means of a pair of plates buried about 4 feet into the ground, and consisting of a zinc and a copper plate, each about three square feet, and placed at a distance of 18 feet apart. After the above period, the various surfaces in contact in the mechanism were so completely oxidized as to require the touch of a file to make them conduct the current freely.

The author was assured, on good authority, that a gentleman in Essex kept an earth battery in action for seven years without interruption. On this subject the author considered further information desirable, as such a battery seems to leave nothing to be wished for. He considered it a question of importance of what nature the soil is in which the plates are buried, whether the negative is a copper plate or a quantity of coke or charcoal, and the distance between the plates.

In respect to the mechanical construction of an electric clock, the author remarked that, unless it is possible to produce one approximating *at least* the excellent "rate" of the ordinary regulators, a clock moved by galvanic force is a mere amusing experiment. In Bain's clock, Fig. 1, the pendulum is moved *directly* by the electro-magnetic power of the coil, besides the force of gravitation; and not only the less or greater strength of the current, but also any inequality in the changing of the same, will either accelerate or retard the vibration of the pendulum, by the attractions and repulsions between the coils A, and the permanent magnet B and C not being effected at the proper moment; in short, the influence to which the pendulum is subject are such as to destroy its isochronism, and the clock ceases to be a proper time-keeper.

Further proof of this is given by the manner in which the train and hands are moved. The power being applied at the lower end of the pendulum D, and transmitted to the train by the fork resting against the pendulum rod at E, it will be evident that the suspension spring F forms a very insecure fulcrum, and that any irregularities in the train of wheels, or in the power required to move the hands, will much more influence the pendulum in this than in an ordinary clock. In the present state of electric horology, we can look upon this arrangement as the crudest form of electric clock.

The author next referred to Mr. Shepherd's successful endeavour of obviating this direct application of the electro-magnetic force to the pendulum, by applying the principle of the so-called gravity escapement between the pendulum and the force. The annexed sketch (Fig. 2) of his arrangement, as applied to the great clock in the Exhibition of 1851 (copied from Tomlinson's "Cyclopædia") will best explain it. The pendulum, while oscillating to the right side, touches a little spring, (situate close to the suspension spring, at *a a* in Fig. 3, and, for convenience sake, left out here), and so forms a contact, whereby a galvanic current is sent through the coils of an electro-magnet, causing it to attract an armature. This latter is fixed to a lever A, which, when moved round its fulcrum or axis C, uplifts an impulsive weight B sufficiently to catch with an upright arm a detent D, whereby the weight is held in its elevated position. Upon the pendulum oscillating to the left, and leaving the spring, contact is broken, the armature is pulled off by a weight E, and the lever A returns to its former position. As the pendulum continues in its vibration to the left, it reaches the upright arm of the detent at F, lifts it off the impulse arm, and so allows the latter to fall against a projecting part of the pendulum G, and to follow it in its vibration to the right side, giving the required impulse. As the pendulum continues swinging to the right, it again touches the contact spring, and the whole process is repeated.

The principal faults the author pointed out were: the wrong manner in which the impulse was imparted; as the plane in which this takes place, although parallel, does not coincide with the central plane of oscillation, causing a twist in the pendulum, called "wobbling;" and, secondly, the very sensible amount of friction caused between the two surfaces, where the impulse is imparted, the two moving in arcs in opposition to each other. Although a great deal was gained in this arrangement, the author considered the pendulum still too much influenced, principally in making contact, for which it has to exert a pressure on the contact spring and bend it to a slight extent, so as to make the contact perfect. The resistance which the contact spring offers to the oscillations of the pendulum being so near the flexible spring by which the latter is suspended will, undoubtedly, lower the centre of suspension during every beat, shorten the pendulum, and so destroy its time-keeping qualities. Any spring, the author declared, however slightly attached or partially connected with the pendulum, will influence the latter by way of its varying strength in different temperatures; and he expressed his surprise that Mr. Shepherd should apply the same plan to a clock exhibited at South Kensington, of which Fig. 3 gives an outline. In this clock the impulse to the pendulum is given by two little balls *d*, suspended by silk threads from arms connected with the vibrating armature. These balls fall into little cups *b*, attached to the pendulum rod in the plane of oscillation, whereby the before-mentioned evil of wobbling is avoided. The author then pointed out Mr. Shepherd's arrangement for employing repulsion as well as attraction for actuating clocks.

Fig. 3.—P, P, are two magnets, over which are suspended two permanent steel magnets H, H, in such a manner that between the poles of the permanent and electro-magnets attraction and repulsion take place alternately with the change of current effected by the oscilla-

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tions of the pendulum, of which the annexed sketch will give the best idea. Doubt was expressed about the economy of large magnets, which Mr. Shepherd stated, in his paper before the Society of Arts, February 26, 1851, to be his opinion. The author considered that facts and physical science would teach the contrary; and stated that a larger magnet with longer wire requires, undoubtedly, greater tension in the electric current, while in a small magnet, with a shorter wire, a weakly charged battery will be able to send a greater "quantity" current through the coil, and so excite a degree of magnetism which can be favourably compared with that of larger ones with the same battery; and hence the surprise expressed at finding Mr. Shepherd using such formidable magnets.

springs are connected with the pendulum, the author could not take upon himself to decide; but he expressed it as his opinion that, under any circumstances, it is advisable, for the production of a really good time-keeper, not to subject the pendulum to the influence of any spring whatever. The difficulty presenting itself here, however, is the making and breaking of the contact, and this the author expressed his belief to have solved effectually, so as to reduce the influence to which the pendulum is subject to a minimum, which, he contended, and attempted to prove, is only possible by the application of the electro-magnetism.

In constructing his clock it was the author's principal object to avoid any spring acting directly on the pendulum, which he effected

FIG. 1.

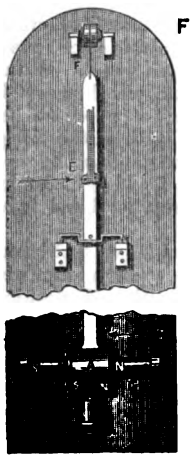


FIG. 2.

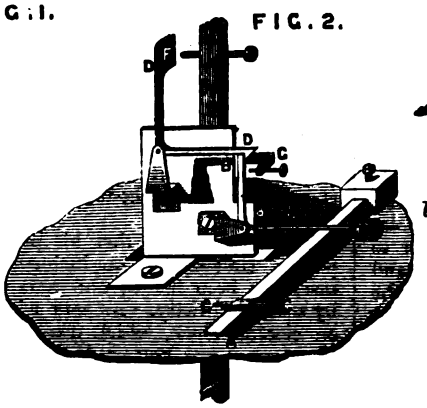


FIG. 3.

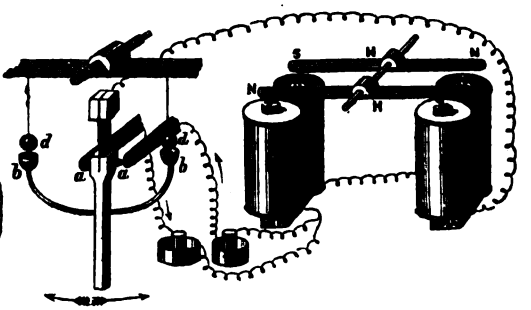


FIG. 4.

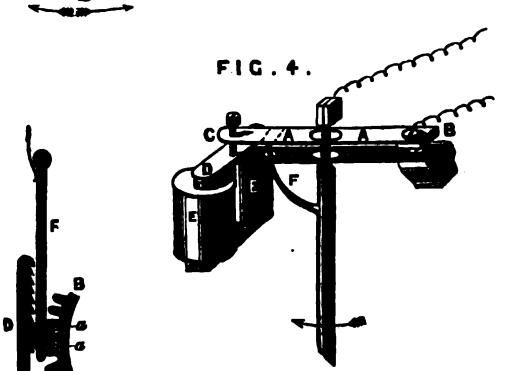


FIG. 5.

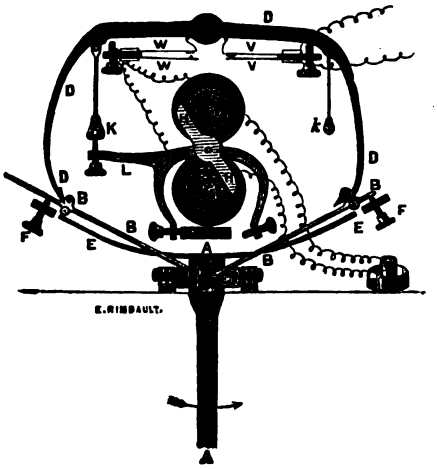
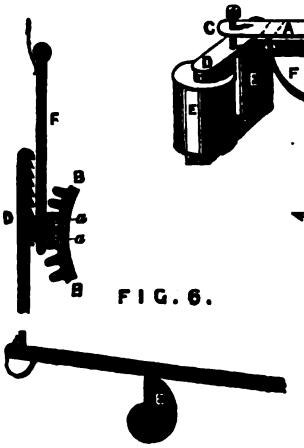


FIG. 6.



To counteract the influence on the pendulum exerted by the spring of the contact maker has been attempted in an ingenious manner by Mr. Cole, whose plan, as shown in Fig. 4 (copied from a clock at the Exhibition), consists of a slight spring, A, surrounding the pendulum at its approximate point of suspension, so as to make the bending point of the two springs coincide as nearly as possible. This horizontal spring, A, being isolated at B, forms the impulse as well as the contact spring. At the other end, C, it rests on the armature D of the magnet E. A little arm F, attached to the pendulum, and pointing upwards in the plane of oscillation, reaches the end of the contact spring A, when, vibrating to the left, contact is made, the armature is pulled down by the magnet, allowing the spring to rest freely on the arm, to ascend with and to descend again until stopped by the armature, when contact is broken, the armature pulled off the magnet, and with it the contact (or impulse) spring is uplifted, until the pendulum returns and remakes the contact by touching the spring. Upon the influence to which the pendulum in this arrangement is subject Mr. Cole reasons in the following manner:—When the impulse spring has increased in power at a low temperature it will have a tendency to increase the arc of oscillation. To a similar, or nearly similar extent, however, the suspension spring has augmented in strength, tending to oppose the increase of the arc, so that the two springs counterbalance each other in their influence on the pendulum. Whether this reasoning holds true, considering the different manner in which the two springs are connected with the pendulum, the author could not take upon himself to decide; but he expressed it as his opinion that, under any circumstances, it is advisable, for the production of a really good time-keeper, not to subject the pendulum to the influence of any spring whatever. The difficulty presenting itself here, however, is the making and breaking of the contact, and this the author expressed his belief to have solved effectually, so as to reduce the influence to which the pendulum is subject to a minimum, which, he contended, and attempted to prove, is only possible by the application of the electro-magnetism.

In constructing his clock it was the author's principal object to avoid any spring acting directly on the pendulum, which he effected by applying a gravity impulse on each side of the pendulum, and making and breaking the contact by means of the detent holding the impulse weights.

The pendulum of this clock (of which Fig. 5 gives an illustration) is compensated in a cheap, and the author believed, a novel manner, principally applicable to turret and house clocks. The rod, being white deal, is baked, and soaked in a mixture of beeswax, oil of turpentine, and linseed oil, and then French-polished to prevent absorption of moisture.

The compensation consists of a zinc tube (sheet zinc) resting on the adjusting nut at the bottom of the wood rod; on the top of the zinc tube rests the cast iron bob by means of a plate screwed to the latter. The proportions are the following:—

Co-efficient of Expansion.

White deal	23
Cast iron	66
Zinc	170

Length in Inches.

Cast iron bob and also zinc tube	7·17
Wood rod ... ... 39·14	$\frac{7·17}{2}$ = 42·72

Expansion Upwards.

Of zinc tube	7·17 × 170 = 1218·90

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Expansion Downwards.

Of wood rod ... ... 23 + 42·72
Of cast iron ... ... 66 + 7·17/2 } = 18·1884

The pendulum is suspended by means of an agate (with the groove inverted) on a cast steel edge (slightly rounded). By this arrangement the dust cannot accumulate to destroy the surface, while the rounded edge produces a rolling motion, preventing the sharp edge of the steel wearing into the stone. The pendulum by itself oscillated 1½ deg. at a quarter to eleven o'clock one evening, which had subsided by about seven the following morning (after eight hours), to ¼ deg. The weight of the pendulum bob, with zinc tube, is about twenty-one pounds.

In the sketch (Fig. 5) A, A, is the pendulum, having a slight cross arm affixed, close to the point of suspension. Nearly coinciding with this point are the centres *c* of the impulse arms B, B, the right one of which, as represented, is held by the curve detent lever D, D. From this latter two weights are suspended, of which the left one is twice as heavy as the right, and would, as given in the sketch, pull the detent lever down on the left, were it not held by the impulse arm on the right. During the oscillation of the pendulum to the right, the cross arm E, E, leaves the left impulse arm, which falls on the banking screw F at the same moment that E, E, takes up the right impulse arm, which latter is uplifted sufficiently to allow the detent lever to escape. The left weight pulls down the lever on that side, and thereby uplifts the left impulse arm from the banking screw. At the same time, however, the detent lever, by being depressed on the left side, forms a contact between the two springs W, W, fixed isolated on a piece of ivory, and each in connection with one end of the wire surrounding the iron magnet G, G. Contact being made, the armature H, H, is attracted. This armature turns on a centre, placed between the two poles of the magnet, by which arrangement the strain on this centre pivot is considerably reduced. With the attraction of H, H, the arm L, and with it the weight K is uplifted, which would cause the detent lever to be depressed on the right side by the weight *k*, did not the left impulse arm hold the detent lever until raised sufficiently by the pendulum when oscillating to the left. As soon as this has taken place the detent lever escapes from the left impulse arm, is depressed on the right side, and uplifts the right impulse arm. But contact being broken at the same moment at W, W, the armature H, H, is pulled off the magnet, and the weight K is allowed to fall. On the pendulum returning to the right, and uplifting the impulse arm on that side, the whole process will be repeated.

The resistance offered to the pendulum in this clock besides that experienced against the atmospheric air, is the force required to disengage the impulse arm from the detent hook, which depends on the weight K, which weight is again determined by the "impulse weight" of the impulse arms, and this again by the amount of force required to disengage these arms; so that *the lighter the impulse arm, the less the suspendent weight, the less the force absorbed in disengaging the detent, and, in turn, the less the weight of the impulse arm to restore that force.* This, the author contended, evidently proves that the influence to which the pendulum is subject from the mechanism by which the oscillations are maintained, has reached a minimum in this arrangement. After dwelling on the advantages of this plan, the author stated that, in connecting a train of wheels with the detent lever to actuate the latter in lieu of electro-magnetism, the influence, as existing in ordinary clocks, would be re-established here; while by the application of electro-magnetism we completely separate the primary force from the pendulum.

The greatest attention, the author believed, had to be directed to the certainty of action of the contact makers, as the capriciousness generally ascribed to the battery was, in his opinion, due to the former. After detailing his experience in various forms of contact makers, the author referred to the subject of magnets and armatures, their form, dimensions, and magnitude; stating his experience, and expressing his belief that a great deal of information could still be obtained by some experiments on this subject to determine the best conditions of magnet and armature for developing "attracting" power, as the experiments of physicists had been made for "carrying" power, *i.e.*, when magnet and armature are in contact.

The author next referred to the manner of connecting the battery with the magnets, so as to allow sufficient time to the battery for recharging itself, as he found that by using one current alternately, one second for the magnet of the pendulum and the next for the magnet of the clock or clocks, the power was very soon exhausted.

The contact springs V, V, in Fig. 5, send a current every other second to the main clock, where a magnet actuates, by a train of wheels, the second, minute, and hour hands. In this clock a contact is made once every minute, sending the current of a battery to any number of secondary clocks connected with it, and placed in various rooms throughout an establishment, as hotel, warehouse, hospital, museum, or palace.

In the main clock the author has employed a plan for moving large hands on public dials in such a manner as to make their action secure. Mr. Denison proposed a design (*vide* "Tomlinson's Cyclopædia," vol. ii., p. 941), which, however, is too complicated for practical application. The arrangement, as applied in the author's clock, consists of two pins *a*, *a*, placed diametrically on a ratchet wheel (Fig. 6), and gearing like a lantern pinion into the minute wheel B, having always one tooth between them. A straight ratchet D gears into the ratchet wheel, which, together with the two pins, performs the revolution whenever the straight ratchet is allowed to fall at the end of the minute, after having been (in this clock) gradually uplifted by means of a cam, E, fixed to the seconds wheel. With a half turn of the two pins a new tooth of the minute wheel passes between them, and the former (the pins) and the ratchet wheel are held in position by means of a kind of pallett F, which rests on the two pins by spring pressure. Under no circumstances can the hand be moved too far, or backwards; and it will always place itself right so long as the obstruction which might temporarily arrest the hand is removed within the minute.

The author stated that his principal object had been to produce a perfect time-keeper, sacrificing even a simplicity which in many cases has been lauded and rewarded, although nothing was gained by such simplicity. As said before, he considered the production of an electric clock, which does not present the features of a perfect time-keeper, or any equivalent advantage, a mere amusing experiment. But, as the great object to be attained in the application of electricity to the moving of clocks is the dissemination of true time, that, when once a true time-keeper is obtained, any number of inferior simple mechanism can be made (irrespective of their perfect workmanship) to show the same time. Not enough stress can be laid upon the necessity of producing a really perfect time-keeper, and this the author contended was only possible, as shown above, by the application of electro-magnetism.

In speaking of the expense incurred in maintaining electric clocks in action, the opinion was expressed that the cost of battery power and attention of a competent clock maker or electrician would be found below that now generally paid by large establishments to clock makers for winding and repairs, as the latter in electric secondary clocks, as well as in the main clock, would be found not to be required for years, in consequence of their great simplicity, unless accidental damage should happen to take place.

The author concluded his paper by dwelling on the advantages of the system, and gave an extract from "The Report of the Astronomer to the Marine Committee, Mersey Docks and Harbour Board," of which the following portions are appended:—

"For communicating Greenwich mean time to ships lying in the river or docks, a time-ball, I (Mr. Hartnupp) believe, is the best means that could be adopted; but, for the convenience of those engaged in the manufacture and regulation of chronometers, and for the public in general, a clock showing the hours, minutes, and seconds, from which the time may be taken at any instant throughout the day, appears to be the most highly appreciated. As a proof of this, on the 4th of February we caused to be counted the number of persons who appealed to the clock controlled from the Observatory, which is placed in the office window of the Magnetic Telegraph Company, and visible from the Exchange flags, and between the hours of six a.m., and five p.m. eighteen hundred and sixty persons took the time from this clock.

"It is scarcely possible to estimate the value of this extensive dissemination of accurate time without referring to the various letters and memorials on this subject addressed to the authorities of Liverpool. They all dwell very largely on the importance of publishing officially accurate time for the benefit of mariners, chronometer makers, and others; and it is stated, in a memorial from the British Association for the Advancement of Science in 1837, that a captain could not at that time obtain the correct error and rate of his chronometer, as celebrated chronometer makers had been found to differ from each other in Greenwich mean time to the amount of two minutes. The memorial ends with the remark—'*these two minutes might cause a wreck.*'"

A writer in the *Popular Science Review*, vol. iv., page 502, amongst the remarks on the above report, says the following:—

"Men are beginning to find that science really has some direct and immediate connection with their pockets and with their palates. Here one misses a bargain because he has allowed the time ball to

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drop before he was at his appointed post; there another loses his train or his packet because he has neglected to set his watch by Greenwich time."

When the trader finds that he has missed a "bargain, his train, or his boat," in consequence of the precision with which matters are conducted under the *regime* of science, he ceases to despise electricity and astronomy, and may even go so far as to inquire into their practical application, and to promote it by contributing a mite from his well-filled purse to some useful or fashionable scientific association.

A NEW SYSTEM OF COOLING AND VENTILATING THE INTERIOR OF BUILDINGS.

THE natives of India are said to obtain ice-cold water, and even ice, by placing the fluid in shallow earthern pans, covered with a fibrous material, which exposes a large moistened surface to the evaporative action of the heated atmosphere. The great capacity for heat of the vapour of water, and of many other fluids, affords a very common means of reducing the temperature of bodies; although until lately this has seldom been scientifically applied on a large scale. The plashing fountain, and the moistened bundle of reeds at the entrance of the Indian's wigwam, are applications of the same principle. Our ladies moisten their temples and lips with *eau de Cologne*, when heat produces faintness or discomfort; but few of them, doubtless, are aware that a plentiful sprinkling with the same fluid would, in the course of a few minutes, freeze to death their little pet "Tiny" or "Myrtle," the more certainly if this favoured quadruped were at the same time exposed to the warmth of the sun or a fire. Among the wonderful and useful things collected together at the late International Exhibition, in the generally stifling atmosphere of the western annexe, was an ice making machine. The ice was produced, indirectly, "by steam," but directly by the evaporation of ether in a vacuum, formed by steam power. Occasionally, when the heat was at its highest, a shower of rain falling upon the roof of the building, and producing evaporation from its surface, exemplified the application of the same principle in producing a refreshing reduction of temperature. It would have been well if the same means could have been employed at will, by an artificial system of producing evaporation from the exterior surface of the roof. Such a system has been invented, and efficiently contrived, by Mr. C. S. Duncan. While, in the heat of summer, it enables us to reduce by many degrees the temperature of any space immediately enclosed beneath the roof of a building, it serves, at the same time, as an effectual means for the suppression of fire. The arrangement adopted is sufficiently simple. The building is connected with the main of the district water-works, by means of cast-iron service pipes, to which a high service supply can be carried to the highest level of the ridge of the roof or roofs. Branching from this high service, horizontal perforated diffusing pipes, varying from about 2 to 4 inches in diameter, are to be fixed along its whole length, with apertures on the upper surface about ¼ of an inch in diameter, over which is to be placed a hood piece formed like an inverted letter V, slightly raised above the level of the diffusing pipe. On turning the tap or cock attached to the main, the water forces itself up the service, entering the diffusing pipes, impinges on the under side of the hood piece, and is spread right and left, like a continued shower of rain, over the sloping sides of the roof, into the gutter, &c., at the same time flushing the drains and water courses.

THE ATLANTIC TELEGRAPH.

From the *Iron Times*.

THE project of forming a submarine telegraphic communication across the depths of the Atlantic, between England and America, is one which must always excite the attention of all, whether we view it in relation to the many profound scientific investigations, which of necessity must be undertaken before success in such a scheme can be secured, or the vast revolutions, both political and commercial, which such a means of communication would infallibly bring about. It is evident all that has been said and written upon the subject has not satiated the public with the matter, for the mere announcement of a paper upon one branch of the investigation necessary in carrying out the scheme was sufficient, on a recent occasion, to draw together, at the meeting of the Geographical Society, the majority of the leading savants and explorers of the present day. The matter submitted to the investigation of the collective intelligence of the assembly was not one of the old and much vexed questions of light or heavy cables, of conductors, of retardation, or of paying out machinery, or such matters more immediately connected with the engineering of the project, but was simply an enquiry into the best method of surveying and becoming acquainted with the depth and nature of the great expanse of ocean which separated the Old from the New World. But slight and insignificant as this branch of the subject may appear, it constitutes the greatest difficulty with which submarine telegraphy has to contend. It is only within the last few years that we have any knowledge of the depths and physical geography of the sea; and, indeed, until very recently, reliable soundings beyond a hundred fathoms were rarely to be met with. Captain Dayman, in the *Cyclops*, was the first who obtained any real information about that large portion of the earth's surface which is shrouded in the mysterious depths of the Atlantic. But even the knowledge obtained by the expedition was of a very negative and unsatisfactory character. The most that was demonstrated by the some half-hundred soundings taken was, that no deeper water than 3,000 fathoms was found. The soundings taken at intervals of from 80 to 100 miles were laid down in a profile chart, and an imaginary line drawn from one to the other, and this the projectors of the old Atlantic Telegraph Company fondly imagined represented a fair section chart of the Atlantic depths.

Let our readers imagine themselves traversing Europe in a balloon, shrouded from the earth by impenetrable clouds, and at distances of every hundred miles or so dropping a line to the ground, and they can easily conceive what kind of knowledge they would be likely to acquire of the elevations and depressions in the European continent. Yet the greatest and most important electric cable which has hitherto been manufactured, was laid without any more extensive knowledge of the nature of the sea bottom which was destined to receive it. The cable failed, but whether from the physical conformation of the bottom, or from its electrical treatment after submersion, must ever remain a mystery. But the plain fact remains, that the injury which caused the failure might have been, and probably was, caused by physical inequalities with which the very cursory sounding failed to make the projectors acquainted. There is, therefore, no excuse for neglecting to make as complete and thorough an examination of the floor of the Atlantic as it is possible to make before undertaking any similar enterprise. It is useless now for enthusiasts to speak of the existence of a "Telegraphic Plateau," of even an unvarying depth, extending from Ireland to Newfoundland, as recent experience has proved the fallacy of any such sanguine belief. There can be little doubt that the bottom of the sea is subject to the same variations of level as the land, and that, without a very close and careful survey, it is doubtful if any submarine telegraphic enterprise can be permanently depended on.

Recent experiences have proved that the line submerged in the Red Sea in 1859 failed in some scores of places entirely from a want of knowledge of, or attention to the varying depths of the waters traversed. Some portions of the line recovered by Mr. Latimer Clark's expedition last year bore most unmistakable evidence of having been suspended from point to point to the extent of 75 per cent., only 25 per cent. of the cable really resting on the bottom. This is a very grave fact, for the failure of the Red Sea line saddled the country with an expense of £36,000 a year for fifty years. We do not say that the system of sounding and examining the bed of the Atlantic recommended by Dr. Wallich in his paper on Monday night is the correct one. But we quite agree with Admiral Sir Edward Belcher, that such matters should be left to the discretion of naval officers commanding the expedition in conjunction with the electrical engineers in charge of the operations. But that no telegraphic enterprise should be undertaken without a thorough survey being made of the bed of the ocean through which the line passes, we, in common with all thinking individuals, must admit.

ALUMINIUM BRONZE.

IN the supplementary number to Vol. XXIV. of the *Philosophical Magazine*, just published, we find a remarkable article by Lieutenant-Colonel A. Strange. F.R.A.S., on the properties and present value of aluminium bronze, an alloy consisting of ten parts of aluminium and 90 of copper. Its tensile strength is stated at 73,185lbs. per square inch, being more than double the breaking-strain of gun-metal, and 1,185lbs. more than the average tenacity of cast steel. Its resistance to compression is 132,416lbs. to the square inch; that of cast iron being 115,542lbs. As to melleability, this alloy may be drawn out under the hammer almost to a needle point at a red heat. Its rigidity is about three times that of gun metal, and forty-four times that of brass; it is less affected by change of temperature than either of the latter; it may be cast with extraordinary facility into any shape; it does not clog the file, and yields fine elastic shavings on the lathe. It tarnishes much less readily in the air than any other metal or alloy used for astronomical intruments, and will receive the finest graduation possible. It is extremely elastic, can be rolled into sheet metal, or also hammered and drawn, and seems admirably adopted for the tubular parts of astronomical instruments. Its specific gravity is 7·689, nearly the same as wrought iron. To make this alloy, extremely pure copper should be used; the best is copper deposited by electricity; but, since that kind is very expensive, the next best is copper from Lake Superior, which makes an alloy of excellent quality.

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The ordinary coppers of commerce generally fail, owing, it is said, chiefly to the presence of iron, which appears to be specially prejudicial. Another precaution is to remelt the alloy two or three times. The first melting, in the proportions above stated, produces an alloy of extreme brittleness; but each successive melting, up to a certain point determined by the working, and particularly the forging properties of the metal, improves its tenacity and strength. The present price of English-made 10 per cent. aluminium bronze is 6s. 6d. per lb., or four or five times the price of gun metal; but as a much smaller quantity of the new alloy would give the same strength, the cost of ordnance made of it would not be very considerably increased.—*Galignani's Messenger.*

INTERNATIONAL EXHIBITION, 1862.

(*Concluded from page* 116.)

It lately occurred to the Superintendent of the Compass Department of the Admiralty (Mr. F. J. Evans, R.N.), in following up some investigations, that the disturbance thus caused being exactly opposite in direction to that part called the quadrantal—which is found more or less in every iron ship (but especially large in amount in armour-plated war ships)—might be made use of to correct that error. On the model in question two compasses are arranged side by side, the distance being adjustible, and a scale being given of the amount of quadrantal deviation in a ship which can be corrected at different distances, so that when the quadrantal deviation is found in the usual way by swinging the ship, the compasses can be adjusted to a corresponding distance. This arrangement has also the advantage of permitting the correction of the remaining part of the deviation to be made in both compasses by one set of magnet bars placed between them.

In the other arrangement exhibited, magnets are introduced in the bottom of the compass bowl, (which is of the ordinary size): and the adjustment for different latitudes is made by the application of magnets of different power. Approval cannot be awarded to this arrangement. The magnets are much too near the compass. The supplying magnets of different powers is not only a rude mode of adjustment, but requires much greater knowledge and practical skill than an adjustment by change of distances.

8.—The iron ships of the present day have generally iron beams, and sometimes iron decks. The effect of this, when the binnacle compass is placed on the deck, is very serious, and it becomes of great importance to have the steering compass as high above the deck as is consistent with being seen by the steersman.

Much taste is displayed in some of the compass binnacles exhibited; their efficiency for iron ships is, however, impaired by being made so low. In any vessel with iron beams, every compass should be at least three feet six inches from the deck.

Mrs. J. Taylor [2,819] exhibits a good liquid compass, fitted in a low binnacle, which latter will no doubt attract the attention of yachtsmen from the neatness and compactness of the design.

To Mr. G. Gowland, of Liverpool [2,902]. for the introduction of a vertical card, useful, especially for elevated positions in iron ships where the ordinary compass card cannot be seen, honourable mention is deservedly awarded. It is to be observed, on this otherwise useful application, that in those which are represented by a thin hoop of steel on which the points of the compass are painted, great care is required in the selection, as they frequently have a large index error. (See Third Report of Liverpool Compass Committee, p. 25.)

England, France, Russia, Holland, Norway, the Zollverein, and Brazil, exhibit mariner's compasses. In the English collection the Admiralty group deserves notice; the standard compass still merits the encomiums bestowed on it by the jury of the Exhibition of 1851. It has since been largely adopted by several of the navies of Europe, and the United States of America. For the progressive improvements, as shown in the Admiralty collection, and for the model of the double binnacle designed for the *Warrior*, a medal is awarded.

J. G. West & Co. [2,812] are the exhibitors of some excellent specimens of liquid compasses. By a self-acting arrangement contained within the bowl (a diaphragm of corrugated metal), their compass, when filled with liquid, retains its efficiency in all changes of climate. For the improved arrangements, combined with excellence of workmanship and attention to details, a medal is awarded.

To an ingenious arrangement of the binnacle top of a standard compass, to secure more exact bearings at night and in rainy weather, exhibited by the nautical instrument manufactory of St. Petersburg, and designed by M. Haritonoff of the Russian Imperial navy [338], as also for an application for preventing vibration by means of fluid below the freely suspended card in an open bowl, which, exhibited in the same compass, promises well for steering purposes, a medal is awarded.

The liquid compass of Dent & Co. [2,894], in its portable and neat binnacle for day or night service, as used by the Life Boat Institution, is a worthy contribution. Deeming it in character applicable, by its portability and efficiency, to the wants of fishermen and small coasting craft, we have awarded it a medal. For the excellent manufacture and beautiful finish of the compasses and binnacles exhibited by M. Santi of Marseilles [1,411], a medal has been awarded.

To P. Cameron, Glasgow [2,872], and to J. W. Blakeney & Co., Hull [2,777], honourable mention is awarded; to the first-named for his appliances to the mariner's compass for the more ready making astronomical observations in connexion with it; and to the latter, for various minor improvements introduced.

In lighting compasses at night, an efficient introduction by Mr. Brunton, of the Compass Department of the Navy, as exhibited with the Admiralty compasses, deserves honourable mention. A simple apparatus in the chimney of the binnacle lamp secures the light against the strongest wind, at the same time allowing the free egress of smoke. Candles for illumination are introduced into some of the binnacles exhibited. In a temperate climate this is doubtless equally efficient and more cleanly than the use of oil; but in hot climates the pressure of the spring in the candle lamps has been found to derange the wick.—*Nautical Magazine.*

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para First Quality	... 2s. 2d.	per lb.
Second „	... 1s. 8d. to 1s. 10d.	„
Third „ (Negro Head)	... 1s. 3d. to 1s. 4d.	„
Java	... 1s. 6d. to 1s. 7d.	„

GUTTA PERCHA.

Fine, none in the Market worth 2s. 6d. and above.		
Genuine good and Mixed ...	... 1s. 9d. to 2s. 0d.	per lb.
Reboiled good	... 1s. 5d. to 1s. 8d.	„
Inferior Reboiled	... 1s. 0d.	„

January 21, 1863. WM. KIRKMANN,

4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	62 to 69	
Stock	Electric Telegraph . .	100	101 to 100½	
5	London District Telegraph .	all	4 to 3 dis.	
10	Mediterranean Extension Tel.	all	3½ to 4¼	
1	Submarine Telegraph, scrip. .	all	⅝ to ¾	
1	Do. registered . . .	all	⅝ to ¾	
10	Do. „ . . .	all	4 to 6	
2	Telegraph to India . .	1	¾ to ¼ dis.	
5	United Kingdom Telegraph .	3	¼ dis. to ¼ pm	

THE FAMILY OF THE LATE MR. SUTER.

WE have to acknowledge the following subscriptions to the fund for the widow and family of the late Mr. Suter,—in addition to those mentioned at page 10 of the present volume:—

	£	s.	d.
H. Collett, Esq. (per J. C. Laws)	1	0	0
F. Lambert, Esq. „	1	0	0
F. C. Webb, Esq.	1	10	0

The fund at present amounts to £41 1s. 0d., and, before closing the list of subscriptions, we hope it may receive further augmentation from those connected with the telegraphic profession.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

TRAIN SIGNALLING.

SIR,—It is said that a good lecturer always assumes that his audience know absolutely nothing of the subject on which he is to address them. Had I kept the same principle in view when writing my first letter to you, your correspondent "W. L." would have been prevented from

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forming so mistaken a notion of the bell system of train signalling. As he has drawn attention to what, if they existed, would be fatal objections to it, I must ask your permission to explain for his information, and that of your readers generally, what the system in practice really is.

1st. All up trains are distinguished by one blow given and acknowledged: once for stopping, and twice for express trains.

2nd. All down trains by two blows, &c.

3rd. *All trains in, i.e.*, clear of a station, by three blows.

4th. Four blows are reserved for a special signal at junctions, &c.

5th. *Danger* is indicated by five blows.

6th. Removal of the obstruction by three blows given and acknowledged twice.

These are all the signals relating to the progress and control of trains. But before illustrating their use, it is necessary to state that the first and most stringent rule laid down is that no signal is complete, or allowed to be entered in the train signalling book, until it has been acknowledged by the station to which it was sent, by the repetition back of the same number of blows; in fact, until this acknowledgment is received, no signal is considered to have been sent at all.

To illustrate the mode of using the bell signals, let us take three stations, A, B and C: A is about to start the first down train in the morning, but before doing so, gives two blows on the down bell at B station: upon its acknowledgment by B, A enters the time of acknowledgment, and starts the train. In the mean while, C requires to despatch a similar up train, and gives one blow on B's up bell, this, after acknowledgment is booked, and the train allowed to proceed. B now knows that an up and a down train are approaching him, but as he is nearer by, say a mile to A than to C, that the down train may be expected first. He keeps a good look out, and as the down train is an express, on its coming in sight, he gives it on by two blows to C: this is acknowledged by C, and the signal, *as in all cases*, booked at both stations. The express train passes B all right, and when it has *cleared the station* B gives the in signal (three blows) to A; A acknowledges, both stations book the time of receipt, and A is then at liberty to despatch another down train. During this time, the up train, a stopping one, has arrived at B, and before being sent on, is signalled by the same precautions to A by one blow, and after clearing B, B gives the three blows to C to signal the up line as clear, and so on throughout the day. Should it become necessary to obstruct the main line either way by shunting, &c., at or near a station, before commencing the danger signal (five blows) is given, acknowledged, and booked, and not until the all clear signal (three blows twice repeated) has been received at the station to which the danger signal was originally given, can a train be started. If any unusual delay occurs in receiving the all clear signal, recourse is had to the speaking circuit for further information.

"W. L's" supposition that the mere "out" signal of a train is held to be sufficient under any circumstances, is thus shown to be groundless. In fact, the safety of a line worked by any form of telegraph depends not upon the out, but the *in* signal of trains; and the invariable rule that no second train is to be started until the in signal of the preceding train has been received and acknowledged.

One great advantage of the signal bells is, that the whole of the battery power being concentrated upon one object, viz, the ringing a bell, the sound becomes a very striking feature, and rarely fails to attract immediate attention. When a bell of much power is combined with any other signal, either a clock alarum bell has to be used with all its liability to derangement, or a local battery is required to work the bell, which involves the use of a relay with its additional contact points, and complexity and costliness of apparatus.

On the whole, while admitting unreservedly, as in my last letter, that at certain points on a line of railway the use of telegraph signals appealing to the eye as well as those appealing to the ear are very desirable, I am not disposed to forego the claim to the advantages of the bell-signalling system generally, as specified in my letter which appeared in No. 60 of the ELECTRICIAN.—I am, sir, your obedient servant,

F. RUDALL.

London, Jan. 13th, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—I was somewhat surprised to see the paragraph in your journal of last week, headed Patent Electric Bells. I have no doubt the fact of using electric bells for domestic purposes, is as familiar to many of your readers as to myself. It is now nearly four years ago that my wife, being ill, in order to save trouble, I took a small electric magnet, and placed it on a board, and fixed a spring, with keeper attached, so as to vibrate in front of the poles of magnets, and altogether it was just the same as the vibrating contact breaker on the induction coil. This I hung on the wall in my kitchen, and connected it with my bed-room, by means of a No. 16 iron wire, for one conductor, and the gas pipe for the other. I have it in constant use still every day; the bell is a common clock-bell, with hammer on vibrating spring to strike the bell. My battery is a small Smee's, the zinc plate about 7 inches by 3, with silver plate to correspond with negative element. This pair of plates, in addition to working my electric bell, work an electric clock, and, consequently, is in constant work. The zinc plate was put in action on January 1st, 1862, and is working well yet. Some time ago, a correspondent, whose name I forget without looking the back numbers over, wrote an article upon the use of electricity in cases of poisoning with laudanum. I can bear testimony to the truth of this. A case came under my own observation, several years ago:—A youth had the drug given to him in mistake; the doctor, knowing I had electric matters about me, sent, and wished me to take a coil and battery. I did so; the youth was quite insensible to the strongest shocks, and was so for some time; but the wires were placed on different parts of his body, and, after about two hours' close attention with the battery, and occasionally sprinkling cold water on his face, he began to manifest pain from the battery effects, and shortly after screamed out; but it was still applied more mildly; he quite recovered, and is now a strong, healthy young man. I should have mentioned this earlier, but have so little spare time to write. Perhaps you will give the above a corner in your journal, if you think it worthy.—I am, sir, yours obediently,

DAVID TUNKS.

Accrington, January 13, 1863.

P.S.—Since I first made my electric bell, I have altered it, so that now I can give single taps on the bell, as in the bell telegraph.

To the Editor of THE ELECTRICIAN.

SIR,—May I be allowed to ask your contributor, Mr. Laming, for some further explanation respecting the following passage in his last article:—

"To have the full advantages of a large wire demands, on the principles we are applying, *that its diameter should be maintained throughout its entire length*, even in the coils of the instruments through which its extremities communicate with the earth, *for no homogeneous wire can have a greater conductivity than its smallest section.*"

The latter italics are my own, and on this point I should be glad to be informed whether the assertion will bear the test of experimental verification. Do not 20 units of resistance of No. 40 wire, added in any part of a circuit of 2,000 units of No. 16 wire, make 2,020 units total resistance. I was of opinion that the contrary view was at the present time completely exploded and disproved.

LONDON DISTRICT.

To the Editor of THE ELECTRICIAN.

SIR,—Will you or any of your correspondents, be kind enough to inform me, through the medium of your paper, how I can construct a powerful coil out of the materials given below.

100 feet thick wire, cotton covered, 2000 feet fine wire.

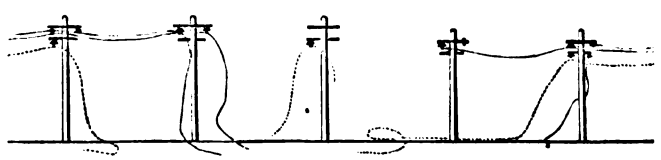
If you would inform me I should be very much obliged. Yours obediently,

C. O. S.

Chatham, 16 *January*, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—I herewith send you a rough sketch of the wires, as they were found at the Parkhill Station, of the Formartine and Buchan Railway, on Monday morning, 22nd ult. The distance between the signalling stations



is 5 miles and 200 yards, the point of rupture being 1 mile and 200 yards from Dyce Junction (not Wyce), and 4 miles from New Machar. Battery power used, 17 cells, at each station, of Tyer's battery. Line wire, No. 9, B. W. G., well insulated. Weather, frosty; earth quite dry, and of a sandy nature. Trusting that some one may be able to account for this somewhat strange occurrence, I am, sir, yours, &c., E. S.

Banchory, 17th January, 1863.

THE HUGHES' PRINTING TELEGRAPH.

ON Monday, the following gentlemen, interested in the science and practice of telegraphy, together with a considererable number of city merchants, visited, by invitation, the central offices of the United Kingdom Electric Telegraph Company, to inspect the working of the printing instrument of Professor Hughes, now in daily operation between London and Birmingham:—

The Right Hon. the Lord Mayor, M.P.; Lord Ranelagh; Sir Frederick Smith, M.P.; Lord Alfred Churchill, M.P.; James Wyld, Esq., M.P.; The Hon. Arthur S. Kinnaird, M.P.; Joseph Somes, Esq., M.P.; Thomas Chambers, Esq., Common Sargeant; Sir Robert W. Carden; Sir Daniel Cooper; Lieut.-Col. Sir Patrick Stewart; J. G. Hoare, Esq.; Henry Barnett, Esq.; Roger Cuhliffe, Esq; J. C. Sharp, Esq.; Thomas Hankey, Esq.; Messrs. Willis & Co.

The exhibition of the instrument pleased and surprised every one. Messages were sent to Birmingham, and, in a few seconds—in fact, before

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the on-lookers became fully sensible that the message was complete—there were printed on the ribbon of paper, the first letters of the reply. We select one of the messages transmitted, and append a specimen of the letter-type.

MESSAGE:—

"BY UNITED KINGDOM ELECTRIC TELEGRAPH COMPANY,

"*Gresham House, January*, 19, 1863.

"The Lord Mayor of London presents his compliments, by the Printing Telegraph, to the Mayor of Birmingham, and joins in the Mayor's congratulation upon electricity being seized upon and put in print. The universalisation of the Electric Telegraph will be promoted the more familiar it becomes, and the more it approaches in the method of its communication to simple existing types. The Printing Telegraph certainly appears a complete step in this direction."

ANSWER:—

"BY UNITED KINGDOM TELEGRAPH COMPANY.
SENT THROUGH THE HUGHES' PRINTING TELEGRAPH INSTRUMENT.

"12.10, *January* 19, 1863.

"His Worship the Mayor of Birmingham, anticipates the pleasure of a conversation by the Hughes' Printing Telegraph, with the Lord Mayor of London."

SPECIMEN OF LETTER TYPE:—

THE LORD MAYOR OF LONDON.

COLONIAL TELEGRAPHY.

THE Colonial Parliament of New South Wales, has agreed to the following telegraphic extensions during the current year:—From Deniliquin to Hay, a length of 80 miles: from Wellington to Dubbo, 35 miles; from Braidwood and Queanbeyan, 35 miles; and also an additional wire on the posts between Sydney and Newcastle. The telegraph to Kiama, which passes through Campbeltown and Wollongong, was opened October 16, with the usual congratulatory message from the Minister for Works. Kiama is conveniently situated on the coast for the observation of vessels coming towards Sydney from the southward, and the station-master is instructed to report to the telegraph office in Sydney, for public information, the names of vessels passing sufficiently near to the port to be distinguished. The telegraph to Forbes (the Lachlan diggings), on the extention from Orange to Wagga Wagga, was opened in November. The line will next be carried on to Burrangong. The extension from Tenterfield to Grafton, a length of 123 miles, was finished in November.

MALTA AND ALEXANDRIA CABLE.

THE following letter, relating to the Malta and Alexandria cable, has appeared in the *Times*:—Sir,—On the afternoon of the 24th of November I addressed a message to Alexandria, which was only delivered to the parties to whom it was directed on the morning of the 29th, the expense being 47s. 9d., against the usual postal rate of 9d. This being the case, my correspondents very naturally returned it to me in order that I might recover the cost of it from the company, justly thinking, as it was upwards of four days in reaching them instead of half a day or a day, the cost of it ought to be repaid me. Of course, in all cases of divided responsibility, one is liable to be reminded of that memorable mansion popularly known as "the house that Jack built," but ultimately the "Continental authorities" were communicated with, and I subjoin the essence of the eminently just and logical reply which has only reached me during the present week:—

(Translation.)

"In answer to your letter, I beg to point out that the message No. 2,082, Southampton to Alexandria 24th of November, arrived there on the 28th of the same month, and therefore much quicker than it could have been forwarded by post. Under these circumstances, there can be no question with the Continental administrations of a return of the charges. I beg of you, therefore, to refuse the application of the sender.

(Signed) "STARING."

Now, sir, in face of this "staring" injustice, the sooner we have a competing line the better, say I; but, in the meantime, it is only right that the public should clearly understand that, if they wish to save about half the average postal time, they may perhaps be allowed to do so on consenting to be mulcted to the extent of some 60 times the usual postal cost. I will only add that, although in this case the delay was said to have arisen in Italy, I conceive the home as well as the foreign companies are all alike interested in the due and regular transmission of messages committed to their joint trust and guardianship for safe conduct to the remotest points,—I am, Sir, &c., MERCATOR.

Southampton, Jan. 15.

Miscellanea.

In a recent paper on Railway Telegraphs, by Mr. W. H. Preece, read before the Institution of Civil Engineers, the principal points advanced in the series of articles under this heading, which were contributed by Mr. Preece to this journal, were submitted to discussion. The advantages and disadvantages of speaking telegraphs in connection with signalling apparatus were considered, and it was maintained that a speaking telegraph should never form a portion of a signalling system, but be a separate and independent agent. The objections to the needle instrument, as regarded its transitory signals, and its liability to reversal, demagnetization, and injury by lightning, as well as its capability of being converted into a conversational medium, were stated to be partially avoided in Mr. Tyer's, and in Mr. Bartholomew's systems. The former was used on the North London and several other lines; the latter on the London, Brighton, and South Coast Railway. Mr. Walker's system of bells, on the South Eastern line, by which an indicator was dispensed with, and dependence placed solely on sound, was mentioned. The French system of M. Regnault, which did not differ essentially from Mr. Clark's—excepting that the "block" was maintained by self-acting mechanism, and not by hand—a questionable alteration—was described. The French "appareils de demande de secours," and the German bell system were deemed to be impracticable in England. It was shown that, in all these systems, the two signals, "danger" and "safety," were not sufficiently opposite in their indications to be unmistakable, and that this was obviated in an instrument invented by Mr. Highton, in 1854, and recently applied on the Great Western line by Mr. Spagnoletti. Written words were given in place of the deflection of a needle. Moreover, the signals in all these systems were so dissimilar to those used out of doors, that the signalmen had to master and retain on their minds two systems, the one line signals, to regulate the trains, the other electric signals, to regulate those of the line. The author then proceeded to describe how he had assimilated, on the London and South-Western railway, the electric to the line signals. The instrument used by him was an exact counterpart, on a small scale, of the signals employed on the line, whether semaphore, disc, or otherwise, and it was worked in a precisely similar manner. The electric signal was simply a distant signal; and it was contended that, if a system of signalling was found sufficient to work the trains by manual power, the same system must be equally efficient when manipulated by electric agency.

BY the repeated actionof nitric acid, and chlorate of potash, graphite becomes slowly changed to a *nearly white* substance, the composition of which, according to Professor Bradie, of Oxford, is $C_{11} H_4 O_5$. The action of dilute ammonia, by which it is gelatinised, and the result of exposure to heat, by which an exceedingly light form of carbon is produced, are among the most striking characteristics of this body.

THE "carbon points" employed in the production of the electric light become converted at their heated extremities into a description of amorgraphite, resembling the finest specimens of Cumberland black acid.

To Correspondents.

A SUBSCRIBER.—Mr. Highton, in his interesting "History of the Progress of Telegraphy," gives the following account of experiments similar to those to which you refer:—"Various experiments have been tried in England, America, and India, with a view to ascertain whether it was possible to send telegraphic communications with naked wires, or even without any wires at all. In England, the author and his brother have tried many experiments on this subject. Naked wires have been sank in canals, for the purpose of ascertaining the mathematical law which governs the loss of power, when no insulation was used. Communications were made with ease over a distance of about a quarter of a mile. The result, however, of these experiments has been to prove that telegraphic communication could not be sent to any considerable distance without the employment of an insulating medium. In India, Dr. O'Shaughnessy has laid uninsulated wires across a river, which is more than a mile broad, for the purpose of transmitting telegraphic communications, and he has found it possible to transmit a current along an uninsulated wire of that length, and to obtain at the distant end, an action sufficient to work his telegraphic instruments, no less than 250 galvanic cells were required, and even then, the signals were scarcely visible. Professor Morse in America, has tried various experiments in sending currents across rivers without intervening wires. All these experiments however, have led to no practical result, except that they have proved, that were it necessary to transmit currents of electricity between two stations which are far distant from each other, insulation of a metallic medium is absolutely required. Beyond the proof of this fact, all these costly experiments have proved futile. The experiments themselves have, however, been of the highest value to the science of telegraphing by electricity, and many laws have been deduced therefrom." To the above, may be added the experiments of Mr. William Watson, 1747, and Dr. Franklin at a later period. Mr. Alexander Bain, conducted a series of experiments in Hyde Park, in 1841-2; and Messrs. Beardmore, Lindsay, and others, at subsequent dates.

E. S.—We have handed your letter to the publisher; and we hope that the encroachment on our space, of which you complain, will not again occur.

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The Electrician.

VOL. III. No. 65.—JANUARY 30, 1863.

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THE SULPHATE OF COPPER BATTERY OF M. MINOTTO.

IN a recent communication to this journal, Mr. R. S. CULLEY referred to a lengthy description of a "new" DANIELL pile in the September-October number of the *Annales Télégraphiques*. This modification will, doubtless, be as familiar to many of our readers as it is to our above-mentioned correspondent, who informs us that he has submitted it to practical trial, with unsatisfactory results. It is formed simply by placing at the bottom of a jar a disc of copper having a wire attached to the periphery, and leading upwards to form the connection, covering this negative element to a certain depth with pulverized sulphate of copper, and then with a layer of fine sand, or other insoluble powder, and placing upon the latter a disc of zinc, which, for telegraphic purposes, may be unamalgamated. It is recommended that the upper part of the wire attached to the copper disc should be varnished, or covered with gutta percha. The battery is rendered active by adding water to the contents of the cell. The small quantity of sulphate solution which is formed is absorbed by the pulverized salt, and, according to M. MINOTTO, is so perfectly retained, by union of its gravity, at the bottom of the jar, that no deposition of copper takes place upon the zinc.

The advantages of this mode of constructing the cells, in addition to a saving of more than 70 per cent. in the annual expenditure for battery power, are stated as follows:—

In regard to convenience—1. The same materials are consumed as in the batteries now employed; but, in lieu of the porous diaphragms, which it is not always easy to obtain of good quality, substances are used which are everywhere to be procured.

2. The cleaning of diaphragms is dispensed with.

3. The necessity of frequently renewing the supply of sulphate of copper is avoided.

4. There is no risk of the corrosion of the reophore (connecting strip) of the positive element. (?)

5. The zinc element may be of any shape, and need not, therefore, be laminated or cast for the purpose.

6. No deposition of copper taking place upon the zinc, this does not require to be so frequently cleaned.

7. The facility of removing the zinc element, without disturbing the connections, renders the operation of cleaning more easy.

8. The internal resistance of the cells may be modified within certain limits, by varying the quality of the sand and the thickness of the layer, or by placing the disc of copper in the middle or above the sulphate salt, to bring it into closer proximity to the zinc.

9. The battery may be made up with a very small quantity of the sulphate of copper, so that its action may cease at any determinate period, a condition which is very useful in certain operations, particularly in electro-plating.

10. The arrangement of the battery is very simple, and requires no special skill.

11. It is not disturbed in moving the cells, or by accidental agitation, which are so prejudicial to the CALLAUD battery.

12. The battery room is kept cleaner; there being no diaphragms to cleanse, and the cleaning of the zincs being less frequent.

The advantage in respect of increased efficiency is stated as follows:—

The constancy of the current generated by the new arrangement may be said to be perfect, as it has none of the liabilities to accidental variation which affect the ordinary DANIELL battery, *i. e.*:—

The efflorescences which tend to establish a direct communication between the two fluids.

The passage of a portion of sulphate of copper through the diaphragms, producing a deposit of copper upon the zinc, and diminishing the action of the pile.

The deposition of copper upon the diaphragms, which obstructs the pores, weakens the battery, and forms several secondary positive elements (?) which increase the consumption of material without contributing to the useful effect.

The neglect of attendants to renew the supply of sulphate of copper necessary to maintain a saturated solution.

The greater internal resistance that it offers, when the plate of copper is placed below the sulphate salt, is very useful in working long lines of telegraph, where the work of the battery is best utilized when the sum of its resistances approximates to the resistance of the line wire and instruments.

We have frequently constructed a battery on the above plan for testing and for experimental purposes; and we can, therefore, give our testimony as to its convenience and economy in the first instance. But we are by no means certain that any ultimate advantage over the form of DANIELL's battery in general use in this country would be found in its adoption for telegraphic signalling. Upon this point, the opinion of many of our telegraphic readers would be of value. We have invariably found, in the DANIELL battery constructed with a diaphragm of sand or other insoluble and pulverulent substance, that a deposition of copper takes place upon the zinc element when the cells have been for some time in action. The amount of this deposit may be reduced, either by adding but a very small quantity of water to the contents of the cell, or by using a positive plate of sufficient weight to compress, in some degree, the sand and powdered sulphate. The former method is inadmissible, on account of its promoting the crystallization of the sulphate of zinc formed by the action of the battery. In some cells we have recently constructed, with discs of zinc of considerable thickness, the deposit of copper is much less than that we have heretofore observed—less, perhaps, than that in sulphate of copper batteries of the ordinary form. In other respects, the arrangement patented in Italy by M. MINOTTO appears at least worthy of practical trial; albeit, its merits appear in several particulars to have been overstated.

CONDUCTIVITY AND RESISTANCE.

BY RICHARD LAMING, M.R.C.S.

IT is required by a correspondent of the ELECTRICIAN that further explanation be afforded of a passage selected from my lately-published memoir. Wishing earnestly to have electrical doctrine better understood, and confident that we may better understand it *if we will*, I prefer, instead of answering by letter, to respond in this more general manner, in the hope of inspiring the will in a greater number of readers.

In the first place, then, it has been no part of my teaching that because an assertion is true of one thing—*want of conductivity*—it must needs be so of another—*resistance*. My interrogator, from education and habit, is assuming the terms to be synonymous, probably without even suspecting the possibility of being in error, and certainly without having perceived how strenuously I have been insisting upon their distinction as absolutely necessary for making mathematical calculations square with physical facts; and which, I may observe in passing, he could hardly have failed to

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perceive had he only read in its context the passage he has quoted. And, again, he and I do not mean the same thing by the same word—resistance. Unfortunately, electrical doctrines are not yet sufficiently settled to have supplied us with a vocabulary of terms which we can all use as a common standard; and, therefore, those electricians who heed not, or forget, my definitions must be liable to misconceive my meaning. I will try to make the present subject plainer by another mode of treating it.

It has been sometimes suggested that there is an analogy between the conduction of electricity by a wire and the passage of water through a pipe; according to my views of electrical action such an analogy may be traced to a considerable extent, and I now propose to trace, it as we shall thereby arrive at the further explanation that has been called for. Let there be a tall reservoir fed by a given stream of water, uniformly arriving and entering its side at some given height that is on a level with the source of supply; and imagine a long pipe to communicate with the lower part of the reservoir, through which some portion of the water is perpetually escaping. The water, being subject to inertia and friction, meets in that fact with a source of resistance opposed to the motive pressure which impels it into motion. That resistance will be greater if the pipe be made longer, because there will be more water moving within it and experiencing the friction; on the other hand, the motive pressure will become greater as the superincumbent column of water is made taller; and the velocity of the water, and, therefore, the quantity issuing in a given time, will vary in an inverse ratio of the length of the pipe, and in a direct ratio of the pressing column. So with electrical conduction; first, the longer the wire the slower is the velocity, by reason of increased inertia, which, according to my researches, causes the resistance with which electro-telegraphists have to deal; and, secondly, the greater the motive tension the greater is the velocity. And it so happens that the friction of the water and the inertia of electricity both vary in the same ratio, namely, as the squares of the lengths of passage. How this takes place in the latter case has been explained in the ELECTRICIAN, No. 59, page 75.

Again: the smaller the calibre of the water pipe the smaller is its conductive capacity for favouring escape under any given motive pressure; and, with electricity, the smaller the sectional area of the wire the less is its capacity for conduction under any given motive tension. We sometimes say in the case of water, as Ohm says with reference to electricity, that the less the conductivity the greater is the resistance. That loose mode of expressing a fact may do well enough for popular uses, but it is not exact enough for science; it is subversive of clear views of physical causation; and, therefore, as an electrician, I have counselled its avoidance, and, in my own writings, limited the meaning of the term resistance to the inertia which is opposed to the motive tension.*

It is assumed, for the mathematical calculations of Ohm, that the force which actuates conduction increases with the resistance opposed to it; by extending the analogy just made use of we may show under what conditions the assertion expresses a fact, and at what point—the conditions ceasing there to exist—it becomes untrue. The water escape pipe, we have been imagining, may have its calibre so adjusted in relation to the supply, that the height of the motive column within the reservoir shall attain its maximum without rising to a level with the source; or the pipe may be so contracted in its calibre that the level of the source shall be fully attained; but no increase in the quantity of water *available to arrive*, or diminution in that escaping, can by any possibility exalt the motive column beyond the height of the source, and thereby further hasten the escape. So with electricity: its motive apparatus will have a motive tension, with a limit which may be reached, but cannot be exceeded, either by making its elements quantitatively of gigantic area, or by elongation of its conducting wire, by which resistance is increased, or by reduction in the diameter of the wire, by which its conductivity is diminished.

If the analogy be so far comprehended, the reader will himself be able to pursue it further into the following particulars. If the diameter of a cylindrical wire be variously reduced at different parts of its length, the *conductivities* at those places will be to one another as the squares of the diameters, perfectly independent of length; because, whatever quantity of electricity can simultaneously pass any one section, can, for the same reasons, under the same circumstances, pass consecutively any greater number of equal sections. *Resistances* vary directly as the length of the wire for each unit of quantity of electricity passing through it: so that, on the supposition of the wire being *equally pervaded by electricity in all its sections*, the resistance is as the length multiplied into itself, irrespective of diameter. Further: in the cases of different wires of unequal sectional areas, *all the matter* being equally pervaded with electricity, the resistances will vary as the squares of the lengths multiplied into the squares of the diameters, which still only makes the resistances to be as the length of the wire for each unit of quantity of electricity. It need hardly be pointed out that the velocities in these last cases will be all equal, because, though the resistances vary as the squares of the diameters, so also do the conductivities, or lines of conduction along which the motive tension is acting.

Now, from all this, my interrogator will, I hope, perceive that I can agree with him that 20 units of length of No. 40 wire, added in any part of a circuit of 2000 units of length of No. 16 wire, will give a total of 2020 units, because no more inertia is experienced in a section of the larger wire than in a section of the smaller one—the electricity simultaneously passing all the sections, being precisely the same in quantity, and determined by the least of them; and still, nevertheless with perfect reason, though in opposition to the teaching of Ohm, maintain that, however great we may make the diameter of certain parts of a wire, while we allow its other parts to remain small, we cannot in the least degree thereby increase the conduction through it, or the resistance offered by it. Telegraphists have been taught, and now receive the dogma with unwavering faith, that by diminishing the diameter of the wire in the coil of a signalling instrument, they elevate the tension and maintain the conduction; but as at the same time they multiply the convolutions, it is at least possible that the maintenance of magnetic effect is due to the substitution of a smaller quantity of electricity rotating a greater number of times, in place of a larger quantity rotating fewer times. Indeed, if the mathematical theory as applied to the coil were true, there should never be an increase in effect on substituting a small number of convolutions of large wire for an equal number of finer wire; in other words, a *quantity galvanometer* should be a thing unknown.

I am asked to say, whether my views of conduction and resistance will bear the test of experimental verification? I must reply, that that will depend upon how we judge of what we see—whether from principles derived from *discovered nature*, which may be of modern date, or from its substitute, *artificial invention*, which may have held possession of the public mind from comparative antiquity. To lay aside the prejudices of education, and to make a wise choice in this matter, is one of our greatest difficulties—one that nothing can help us over but free discussion. And here it may be useful to say a word about the public discussion of electrical doctrines generally. If the free ventilation of a difficulty be the way to arrive at its solution, how is it, with the pages of THE ELECTRICIAN open to all reasonable questioning, that men professing to be in search of electrical truth, and needing it for their professional guidance, shrink back

* I am not forgetting the reputed imponderability of electricity, with the want of inertia appended to that doctrine; but, as I have succeeded in an experiment, pronounced faultless by a scientific commission, and that by means of the balance proves electricity to be heavy, I cannot be deterred by an antique and unsupported prejudice from giving to it the property observation has more latterly assigned to it, and which is obviously calculated to remove an impediment long lying in the way of scientific advancement in more than one direction. An account of the weighing of electricity before the President and other members of the *Institut de France* may be found in the writer's "*Matter and Force*," published by Taylor and Francis.

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from its public discussion? Is it that, indebted to some fortunate accident of commercial, or academical, position, for being supposed to know more than any of their compeers, they feel taciturnity to be the best discretion? I have seen it recommended, somewhere, as the sublimity, both of nature and art, and the lesson may be a profound one :—

"To teach men, as though you taught them not;
To tell new truths as those they had forgot."

But it is not every teacher whose art is perfect enough to succeed in doing this, or whose nature is sufficiently self-immolating to attempt it, when, after all, his pupils may never become conscious of having heard anything they did not know before—that they had not long ago seen through with half an eye.

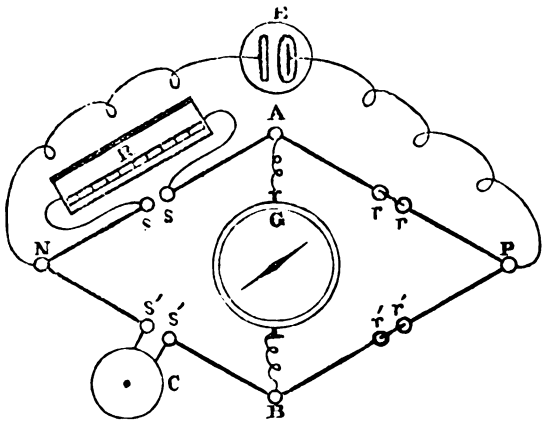
When a philosopher, throughout a long life, remarkable for originality of conception, unsurpassable manipulation, and unimpeachable veracity, has mounted, by his discoveries, one step after another to the summit of a shrine before which the whole world bows with as much of worship as is permissible, we can indulge, if not approve of, his wish never to be committed to a public discussion, and deem it time enough to call his opinions in question when, in the natural course of things, allegiance may be peacefully withdrawn, and innovation cease to give pain. We can do this from sympathy, if not from philosophy; but we shall hardly extend our weakness so far as to include lesser men in the same indulgence; and few will have any cause to complain, if, in systematically avoiding public discussion, they are supposed to have cause to fear it.

WHEATSTONE'S BRIDGE OR PARALLELOGRAM.

THE ingenious instrument which is known by this name affords an excellent, and perhaps the best, means of measuring resistances; and is, consequently, most useful in the practical operations of electro-telegraphy. It is formed of a parallelogram of thick wire, A N B P, let into a groove in the surface of the board which forms the base of the instrument. The wire is interrupted at *s s s' s'*, and also at *r r r' r'*, to which points binding screws are attached for the insertion of the resistance to be tested, C; a resistance coil, R; a rheostat, and occasionally a galvanometer or another known resistance of wire.

The opposite angles, P and N, are attached, by means of binding screws, to the poles of an electrometer, generally one cell of Daniell, E; and the angles A and B are attached to the extremities of the coil of a delicate galvanometer G, placed in the centre of the board.

Fig. 1.

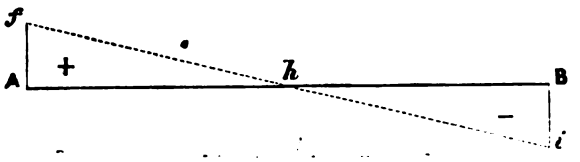


To understand the action of the instrument, let us suppose the wire to be unbroken at the points *r r* and *r' r'*, and, therefore, P A and P B equal in resistance, a current will pass from P to N; and, if the two sides of the parallelogram A N and B N are also equal in resistance, the quantity of electricity passing through each channel will be exactly one-half of that traversing the circuit. Under these circumstances, no portion of the current will traverse the diagonal from A to B, and the galvanometer G will remain unaffected. This will also be the case if equal resistances be inserted at *s s* and *s' s'*.

But, if the resistance of the side A N be not equal to that of the side B N, a portion of the current will traverse the galvanometer G, the needle of which will be deflected until the resistances be equalised. Let us suppose, for instance, that the coil C, the resistance of which is to be measured, is attached to the binding screws at *s' s'*, while those at *s s* are united by a conductor offering no appreciable resistance. In this case a portion of the electricity, which, under the former conditions, traversed the sides P B, B N of the parallelogram, will take the path of less resistance through P B, B A, A N, and the galvanometer placed between B and A will be deflected. If, now, a number of determinate units of resistance be introduced at *s s* by means of the resistance coil or rheostat, until the needle of the galvanometer returns to zero, the former conditions will be restored, and the resistance of the coil C will equal the known resistance inserted at *s s*.

The current traversing from B to A will be proportionate to the difference of the tensions at these two points. Now the electrical tensions in a conductor joining the two poles of a source may be represented as follows:—by a diagonal *f i* uniting the extremities of the perpendiculars, A *f* and B *i*, measuring the tensions at the opposite poles.

Fig. 2.



From this it will be obvious that, when the circuit through the parallelogram is completed without the insertion of any appreciable resistances at *s s* or *s' s'*, or at *r r* or *r' r'*, the points A and B, in Fig. 1, correspond to the point *h* in Fig. 2, where the tension is *nil*, and that no current can therefore traverse the galvanometer from A to B, or from B to A. Again, when equal resistances are inserted at *s s* and *s' s'*, or at *r r* and *r' r'* (Fig. 1), the *difference* of tensions at A and B remains *nil*; these tensions being necessarily of the same sign and equal in degree.

ON THE RELATION OF SCIENCE TO ELECTRO-PLATE MANUFACTURES.

BY GEORGE GORE.

[From the *Popular Science Review.*]

LITTLE did Gay Lussac think, when he discovered cyanogen, in the year 1815, the great influence which that substance would have upon the comforts and luxuries of every-day life. Prussian blue, the substance with which laundresses colour linen, and which is composed of cyanogen and iron, was, it is true, known as long ago as the year 1704, when it was discovered by Diesbach and Dippel, in Berlin; but that this substance contained cyanogen was not known until Gay Lussac discovered it.

All experimental knowledge generally passes through three stages, viz.: discovery, invention, and practical daily working: a philosopher discovers some new fact or principle in nature; an inventor applies it to some useful purpose; and a man of business brings the invention before the public, and continues it in daily use.

Suppose that Gay Lussac had not discovered cyanide of potassium, and that it had never been discovered, it is highly probable that the manufacturing returns of Birmingham, Sheffield, and other places in which electro-plating is conducted, would be much less in amount at the present time than they are, simply because there is no other known substance with which the electro-plating of base metals with gold and silver can be satisfactorily effected.

The base of every article which is coated with a thin film of silver for domestic purposes by electro-plating, consists of an alloy of three metals—copper, zinc, and nickel; this substance, commonly called nickel silver or German silver, is chosen for this purpose, because it possesses a white colour nearly allied to that of real silver; and when the outer coating of noble metal is worn away by use, the exposed baser portions do not present the unseemly appearance that they would if a metal or alloy of another colour, such as copper or brass, had been used.

Nickel was discovered by Cronstedt in the year 1751, and is now a metal of considerable importance in the towns of Birmingham and Sheffield; the galvanic battery was discovered by Volta in 1800, and magneto-electricity by Faraday about the year 1830. Without the discovery of nickel we should have had no nickel refineries, nor German silver manufactories; and without galvanic and magneto-electricity the extensive trade of electro-plating would never have

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sprung up, and the manufacture of galvanic batteries, telegraphic instruments, and especially of the immense quantities of telegraph wire now consumed, would never have existed.

These and other kindred scientific truths having become commonplace facts of everyday life, we are apt to think that abstract science has had but little to do with their production, and we are thus unconsciously led to undervalue the importance of abstract scientific investigation.

It is true that many processes of manufacture have not been consequences of abstract scientific discovery, that they originally resulted from alterations made in the rudest artistic appliances, and that they have been directed and improved by the results of experience. For ages past we have been deriving the benefit of scientific principles without a knowledge of their existence; we have trodden in the beaten path of experience, ignorant of the truth that we were acting in unison with fixed and certain laws. Numerous arts and processes were in extensive operation long before the principles involved in them were at all understood; the arts of enamelling and of iron-smelting were known hundreds of years before we were acquainted with the principles of chemistry. In some instances the recorded results of daily experience in practical matters, tabulated and studied, have lead to the discovery of scientific laws, but this is merely the making use of our ordinary experience for the advancement of knowledge, instead of making *special experiments* for the purpose.

It is also true that many discoveries remain a long time before they are practically and extensively applied, that some made long ago have not yet found a practical use, and persons of superficial minds, therefore, frequently inquire, "what is their use?" Their use is to assist in the development of other discoveries, and to be ready at the command of the inventor, who applies them to useful purposes. Of what use were the various abstract investigations upon specific heat, latent heat, the tension of vapours, the properties of water, the mechanical effect of heat, &c., by Black and others, but to be ready for the illustrious Watt to apply in the steam-engine? Of what use was the discovery of atmospheric electricity by Franklin, but to lead to the preservation of human life by means of lightning conductors?

It is true that many things which have appeared very promising in theory or experiment have failed altogether in practice, but why is this? It is not that the principles of nature existed in the one case, and did not exist in the other, but that we have imperfectly understood them; that from some unforeseen circumstances we have been unable to apply them, or that we have indolently abandoned them without sufficient or proper trial.

In many cases we are unable to obtain the same conditions of success upon the large scale that we have upon the small scale; if we melt some brass in a crucible, and cover it with a layer of borax, and dip a piece of perfectly clean iron into it, the iron will receive an adhesive metallic coating; but if we attempt to coat very bulky articles, such as sheets of iron, by this process we fail, because no vessel will withstand the heat and great weight of the melted metal.

In other cases a process fails because of its too great expense; many attempts have been made to supersede steam as a motive power by means of electro-magnetism, and engines driven by that force have been constructed of five or ten-horse power; but the cost of driving them has been found to be at least ten times the amount of that of a steam-engine of equal strength.

And in other cases we fail because we attempt *at once* to carry out upon a large scale that which has only been the subject of a small experiment, instead of enlarging the process by small degrees, and adapting the apparatus, the materials, and its treatment, to the size of the operation.

That which appears very simple in the hands of an experimentalist almost invariably becomes much more complex when carried into practice in a manufactory, simply because there is then a greater number of conditions to be fulfilled. Electro-plating a piece of steel with silver is to a chemist a very simple matter, because it is of no importance to *him* whether the silver adheres firmly, is of a good colour, or is deposited at a certain cost; but with a *manufacturer*, unless *all* these conditions are fulfilled, the process is a failure.

No towns have perhaps benefited more by scientific discovery and its application to trade, than Birmingham and Sheffield—the former in particular. The great bulk of the articles manufactured there being composed of metal, are produced and ornamented by mechanical and chemical processes, and therefore offer peculiar advantages for the application of mechanical and chemical knowledge.

Many manufacturers seem to think that because their operations are so completely routine, and have been handed down to them by their predecessors in nearly their present state, they are not at all indebted to science: but there is no manufacture, especially amongst metals, which does not continually involve scientific knowledge.

Not only has science benefited manufacturers, but also operatives, because the extension of science to manufacturing purposes has compelled them to make themselves acquainted with intellectual subjects. Instead of remaining mere machines, mechanically performing the work set before them, they are obliged to exercise the faculties of observation and judgment in watching the results and directing the action of mechanical, physical, and chemical forces. Instead of following the blind path of experience, using unknown forces to accomplish some definite result, they pursue their labours with the aid of known and certain laws.

No man has more occasion to bless the introduction of the steam-engine, machinery, the galvanic battery, and science in general, than the working mechanic, because it has mitigated his physical toil by giving him the duty of simply directing the labour instead of actually performing it: whilst it has deprived him of one kind of employment it has provided him with something better. But a few years ago the operatives in the silver-plating trade had to lay the silver on the articles with their hands and the aid of a soldering-iron; *now*, they have simply to set their batteries in action, and watch the electricity doing it for them. In a similar manner the working engineer at his metal-turning lathe has merely to direct the action of his tools whilst the steam-engine performs the heavy labour of turning.

In the present period of scientific progress, when the attention of men of business is so frequently attracted to some new invention or discovery which appears likely, if not to supersede their particular occupation, at least to have some influence upon it, it is the interest of every such person to watch the progress of science, and to seize it for his own advantage, instead of allowing others to do so, and thereby divert his trade into other channels.

No art nor manufacture is so perfect as to be exempt from the influence of discoveries and inventions, and no man can produce so perfect an article, but that by the aid of science a better may be produced.

In what consists the great success of applying science to trade?—simply the influence of demonstrable truth. We know that if we have once discovered all the laws or conditions of some improved process or result in a manufacture, the reproduction of exactly the same conditions will hereafter enable us to invariably produce the same result. In this respect science differs from empiricism, for in empirically working a process we are ignorant of the condition or laws which are operating, whilst with a scientific knowledge we understand those laws, and can direct them to our particular purposes. In the process of electro-plating, we understand the laws of the phenomena, and can direct them so as to obtain silver of a hard or soft quality, brittle or tough, crystalline silver, &c., according to our pleasure; but if we had only an empirical knowledge of the subject, we could not thus vary the process.

The great success of coating articles with silver by the electro process depends in a very large measure upon the demonstrable fact that alkaline cyanides have a strong affinity for noble metals, and but little affinity for base metals; no other substance possesses this quality, or at least in so eminent a degree. In proof of this fact, I have twisted together two similar-sized and clean pieces of very thin wire, the one piece being gold and the other iron, and immersed the double wire in a solution of cyanide of potassium; in about six weeks the so-called "indestructible" metal, gold, was all corroded and dissolved, whilst the base and "destructible" metal, iron, was as bright and perfect as ever. Further, if two pieces of wire, the one being of gold and the other of iron, are connected with the ends of a galvanometer, and their extremities immersed in a solution of cyanide of potassium, or other alkaline cyanide, the noble metal will be found to be electro-positive to the iron; and a galvanic battery of weak power might even be constructed of those three elements, which would present the singular anomaly of generating an electric current *in an opposite direction* to that in all other cases obtained.

So great a resistance has iron, and so strong an affinity has silver to be dissolved by a solution of cyanide of potassium, that if a current of electricity is simultaneously sent through both into that liquid, the electricity will pass freely as long as there is a portion of the silver remaining, and the silver will dissolve rapidly; but as soon as all the silver has dissolved the current will be nearly stopped, and the iron, instead of dissolving, will liberate bubbles of gas.

This is precisely the condition that was required for the success of electro-plating, viz., a liquid which should not corrode (as *acid* liquids do), the articles of base metal immersed in it, and should easily dissolve and retain in solution the noble metals with which the articles were to be coated, and at the same time conduct electricity readily,

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and not lose those qualities by exposure to atmospheric air; alkaline cyanides are the only known liquids that fulfil all these conditions.

(*To be continued.*)

THE HUGHES' PRINTING TELEGRAPH.

THIS instrument was first introduced in America as a time and labour saving apparatus, and it has continued to give great satisfaction. The American Telegraph Company reports, through its President, that it is considered there to "be enormously superior to the Morse for rapidity and accuracy." The Morse, and the single and double needle systems are those at present in use in this country, the Morse being, however, superior to the needle apparatus.

From America the apparatus travelled to France, through Great Britain. In this country, with the old established systems, there was little disposition to favour a novelty which must supersede the whole of the costly plant in operation at the time, and to France, accordingly, the inventor next applied. Here several important modifications and material improvements were effected; and a commission, composed of practical and scientific gentlemen, was named to report as to the capabilities of the instrument. The report made was unanimously in its favour, and the administration was recommended to give it a trial on the French lines. A preliminary contract was made with the inventor, constituting the officials the sole judges whether the instrument worked satisfactorily or not, and the apparatus was set in operation. The results obtained, after a severe trial over a lengthened period, in which the apparatus was pitted under like conditions against the existing Morse and other systems, were so satisfactory that the instrument was definitely adopted, and forthwith placed upon the most important and busiest circuits in the country.

Other administrations, on receiving, from French sources, reports of the capabilities of the printing system, communicated with Professor Hughes, the inventor, inviting him to try his instrument on their lines. The first overture was made by the newly constituted kingdom of Italy. Here, again, a scientific commission was appointed; again the new invention underwent a theoretical ordeal, and a succession of practical trials, and again with the same results; only that on this occasion, a month was found amply sufficient to prove its merits. The administration adopted the apparatus, and were so gratified at the results obtained that the Order of St. Lazaire was bestowed upon Professor Hughes, "in recognition of his splendid invention." Large sums of money were paid for the use of the patent rights, both by the French and Italian Governments.

About this time, the United Kingdom Telegraph Company had gained its Act of Parliament and was getting into operation, introducing a uniform charge of one shilling for messages for any distance. Although, with the apparatus at present in use, the company could have effected this, they were narrowly watching and were therefore acquainted with the proceedings in France and elsewhere. This new invention was evidently just the thing required. The importance of a quicker and more correct instrument in carrying out the new system of shilling messages could scarcely be overrated, and accordingly, at the right moment, a provisional arrangement was made with the inventor to try the instrument on the company's lines in England, the company being the sole judge as to whether the apparatus fulfilled its requirements, and the inventor paying his own and all attendant charges, whatever the result arrived at. The company to possess the exclusive use of the patent in this country.

Instruments were accordingly set practically to work in all weathers, and under all conditions. The operators were the company's own female clerks, taught for the occasion, and although, from their short period of practice they were necessarily unskilled, an average speed was obtained of between forty and forty-six messages, of average length, per hour.

The great and striking advantages of the Hughes Printing System are, that a single wave of electricity produces a letter, or numeral, whereas about three-and-a-half are required for each Morse symbol, and some symbols require waves of long duration. The consequently greatly increased speed attained by the Hughes apparatus. This one wave produces an ordinary printed letter instead of a cabalistic mark. The instrument prints at both ends of the wire simultaneously, so that the sending clerk sees what he is forwarding. No copying or translating being required, as in other systems, this chance of error is avoided. The merchant receives his own message as sent, in clear type, and thus may feel confidence in its correctness. The impossibility of error from atmospheric influences or interruptions, as caused at present, there not having been one error made during six months' working between Marseilles and Paris. The steadiness and certainty with which the waves of electricity are transmitted, they being sent by mechanical means instead of by the human hand. The facility of interruption or asking questions from either end. The sensitiveness of the instrument in bad weather. The fact that the electrical wave simply releases not attracts a magnet, and that the whole of the printing, &c., is performed by mechanical means. The steady average speed attained, the Morse and other systems working very slowly in wet weather.

The speed secured in France has reached, for days together, fifty messages and upwards per hour per wire, and from forty to fifty words per minute. In America, the apparatus is officially reported as performing upwards of forty words per minute; and at the office of the United Kingdom Company from thirty up to forty words per minute, and forty to forty-six messages, of average length, per hour per wire, have already been sent. The apparatus promises nearly to double the average performances of the Morse and the needle instruments at present in use.

There is a key-board attached to the instrument, on which the letters of the alphabet are placed; these correspond with the type-wheel, and each time a key is depressed a letter is printed. The key-board is identical with the key-board of a piano, and female operators are consequently found to be admirably adapted for the work.

Mr. Bright's speech was transmitted from Birmingham by the printing instrument for the London daily papers, on Thursday night last.

EXTRACTS FROM THE EVIDENCE OF SIR JAMES ROSS BEFORE THE GOVERNMENT COMMITTEE.

CAPTAIN GALTON, R.E., to SIR JAMES ROSS.—You have had considerable experience in Polar navigation?—Yes, I have passed 10 winters and 20 summers in the Polar seas.

We wish to obtain your opinion upon the practicability of laying a submarine cable from England to America, either by Iceland or straight to Greenland, and thence to Labrador, instead of laying a submarine line direct across from Great Britain to Newfoundland?—From what part of England do you intend to start?

The north coast of Ireland we have thought probably would be the best point to start from; but a further suggestion has been made, that the line should start from the Shetland Isles, thence to the Faroe Islands, and thence to Iceland, or direct from the Shetland Islands to Labrador, leaving the point of departure from England entirely open?—There would be difficulty in laying the cable to the Faroe Islands on account of the strong tides and whirlpools, and the abrasion of the cable against the rocks would necessarily be very great; so that, at any rate, I think, it would be better to avoid the Faroe Islands. As to Iceland, the same objections apply in a less degree, but with the additional one of the ice coming down along the east and west coasts, which would be very likely to interfere with the cable.

Even on the south coast of Iceland would it be impossible to find a place to land a cable?—On the south coast of Iceland there are very strong tides as there are on the Faroe Islands, though not so dangerous.

Do the tides set round the island?—They come from the north along both shores, and at the south they form into eddies.

Is the ice cast on shore at the south side by those eddies?—It is not cast on shore; the greater portion of the ice is upon the east and west sides of Iceland; the pressure is not great upon the south side.

MR. FAIRBAIRN.—Would not the pressure of the ice be great on the north?—Yes. There would be no possibiliiy of landing a cable on the north shore; it is scarcely ever free from ice.

CHAIRMAN.—If the icebergs did not ground to the south of Iceland, do you think the ice would be liable to injure the cable?—The cable would be liable to be injured by the ice drifting along the coasts.

By floating, grounding, or would the mere shore ice be likely to injure it?—There is no fixed shore ice there, as there is on the Labrador coast; but the ice in drifting past might destroy the cable if very heavy. It is generally deeper ice there than anywhere else, but there are no icebergs to interfere with the cable; the icebergs are all on the west side of Greenland. On the east side of Greenland there is none formed.

Therefore Greenland is not exposed to ice?—The east coast of Greenland is not exposed to icebergs, but is inaccessible on account of the floe ice.

Then the ice you have mentioned is floe ice or flat ice?—Yes.

To what depth?—Generally from 15 to 20 feet; it may be sometimes as much as 30 feet.

MR. STUART WORTLEY.—Does the ice actually form upon the shore?—Upon the south coast of Iceland it does not, but it comes down upon

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the north and west coasts, and becomes fixed there in the winter season.

CHAIRMAN.—If I understand, you would not recommend a cable being laid to Iceland?—I should certainly not recommend a cable being laid to Iceland. I should prefer laying a cable from some part of Scotland to Rockall in about 13 or 14 longitude, and then from Rockall I would go direct to Cape Farewell in Greenland.

Mr. STUART WORTLEY.—Do you know what that distance would be?—I do not know exactly, about 900 miles.

Mr. FAIRBAIRN.—Would not there be some danger at Cape Farewell, of the ice floating down there, round the east coast?—There would be danger, but as you cannot land on the east coast, you must go round the cape and land it on the west, or rather, south-west, coast, where the ice does not come in with so much force. There are several fiords, between Cape Farewell and Cape Desolation, some one of which might be suitable.

CHAIRMAN.—How far is Rockall from Scotland?—I think about 300 miles.

You would go round Cape Farewell, if I understand you, into some of these little inlets?—Yes, Julianeshaab or Fredericshaab.

Between Cape Farewell and Cape Desolation?—Yes, the Danes have a colony at Julianeshaab.

Do you think that it would be necessary to carry the cable inside the Straits of Belleisle?—I should think it would be better to take it higher up the Labrador coast.

Have you no fear of the icebergs or floating ice cutting it?—Yes, there is the great danger; the most difficult part would be laying the cable to the coast of Labrador, I think.

The suggestion about the straits of Belleisle was assuming that the icebergs did not ground off the mouth of the river St. Lawrence?—I am not aware how that is. I understood that the intention was to have gone much further north, but I think there is a great objection to that. Parallel with the coast of Labrador there is a bank of rock and sand, in latitude 57½° N., extending 30 or 40 miles. I have crossed it on two occasions; the depth is only 60 fathoms. A long line of icebergs was aground upon that bank, which it would be necessary to avoid How far it extends to the southward I cannot tell.

Does that bank extend as high up as Cape Chudleigh?—I do not know. I crossed it south of Cape Mugford, near Okak, the Moravian settlement.

Mr. STUART WORTLEY.—In which direction does that bank extend from Cape Mugford?—It extends both ways; it is parallel with the coast both north and south. The line of icebergs marks the shoal, because they always ground upon it; you can tell the position of the shoal by the grounded icebergs.

CHAIRMAN.—It has been stated that there is a bank running from near the coast of Greenland across the mouth of Davis's Straits towards the coast of Labrador, which prevents icebergs of more than a certain size passing to the southward; is that correct, according to your experience?—I am not aware of any such bank. I do not believe that there is any such bank in existence.

Admiral AUSTIN.—I think if you had a chart showing the soundings, it would point out all that portion of the shoal water where icebergs would ground.

Admiral FITZROY.—According to the latest Admiralty charts, that part has never been sounded; there are no soundings published at present that are not laid down in one or other of those two charts.

Sir J. ROSS.—Captain Washington has a chart with a number of soundings, that I gave him, which are not on either of those charts. I had them put on to a chart myself in manuscript.

CHAIRMAN.—Do you recollect generally what those soundings were?—No.

Did they exceed 1,500 fathoms?—We were not in the habit at that time of sounding such great depths; the greatest depth was 1,000 fathoms.

Was the depth under 1,000 fathoms?—It was above 1,000 fathoms; at 1,000 fathoms we did not strike the ground.

Upon the whole, your opinion seems to be rather adverse to a line carried by the coast of Greenland?—I think it would be a very difficult route.

And be very liable to injury?—Very liable to injury. I can scarcely give an opinion upon it, because there might be deep water from Cape Farewell to some part of the Labrador coast, with which I am unacquainted, where a cable might be landed; certainly not to the northward of Cape Mugford.

Mr. STUART WORTLEY.—What is the farthest point northward where you think there would be any chance of landing a cable?—I am not able to judge; as far as I saw, the icebergs grounded north and south.

You actually saw thirteen or fourteen miles of ice?—Certainly, twenty miles each way. Further to the south that bank may cease, and the cable might be laid in deep water, so as to prevent the icebergs touching it.

Do you think it possible to judge of the practicability of laying a cable across these seas without a more accurate survey of the bottom?—I think it would be very unwise to attempt it. The first step should be to get a line of soundings.

Mr. FAIRBAIRN.—Have we any record of soundings from Scotland to Cape Farewell, so as to ascertain the possibility of laying a cable in that direction?—No, I do not think we have. I do not know of any such line of soundings. It is certainly 1,000 fathoms deep in some parts, and it may be 2,000 for what we know.

Admiral AUSTIN.—I should think under any circumstances where you are going to lay a cable in the locality of ice it would be most important to have soundings taken. Wherever there are icebergs the most certain mode of avoiding them would be to lay the cable in the deepest water.

Mr. FAIRBAIRN.—Would it not be very unsafe and uncertain to lay a cable in any case unless you had soundings?

Admiral AUSTIN.—Yes, particularly where there was ice.

Mr. STUART WORTLEY to Sir J. ROSS.—Is there a current known by the name of the Spitzbergen current?—Yes, it is a reflection of the Gulf Stream which comes round to the east and north of Spitzbergen and then passes to the southward between Iceland and Greenland.

Does it run down the east coast of Greenland to the extreme southward of Cape Farewell?—Yes, and after passing the Cape, it runs up into Davis's Straits, as far as Queen Anne's Cape, where it meets the Baffin's Bay current, and is turned by it to the south, along the coast of Labrador.

Is not there a quantity of drift wood brought down from Arctic Asia?—Yes, the drift wood is landed on the coast of Spitzbergen in tiers five or six feet high; along the whole line of coast the piles upon the beach would be ten or twelve feet in breadth.

Is any drift wood cast upon the coast of Greenland?—I do not know; we always met drift wood when we got into this stream; we saw trees floating about, but I do not think it is cast upon the shore because the current turns round Cape Farewell and runs north again; but it does not go so close in shore as to land much drift wood.

It does not go round the coast upon the west side?—No; as soon as it reaches Queen Anne's Cape, the current brings it down upon the coast of Labrador.

Does not the drift wood occasionally become the nucleus of large ice-fields; does not it get frozen together?—No, I have never seen any in that condition.

CHAIRMAN.—Have you visited the coast of Labrador sufficiently to be able to say whether there are indentations which would be favourable to the landing of a cable?—No, I have only landed at one place in Labrador, that is Okak, the Missionary establishment to the south of Cape Mugford.

There appeared to be fiords or deep indentations?—Yes, but you could not avoid the bank. It would not do to attempt to land a cable there.

CHAIRMAN.—The fiords are not favourable places for the landing of a cable?—Admiral AUSTIN.—Not where the ice is formed.

To Sir J. ROSS.—From what do the icebergs form?—The icebergs form from the glaciers; in the northern part of Baffin's Bay there is a vast extent of coast, where the whole country is covered with ice, and there is not a particle of land to be seen amongst it. These vast glaciers gradually slide down and break off, in pieces of various shapes and sizes, and form the icebergs.

Mr. STUART WORTLEY.—What is termed pack-ice?—That which is formed on the sea; the other is snow-ice.

Is there also another description called floe-ice?—Yes.

Does that form in the fiords?—Yes.

Does it reach the shore in the fiords?—Yes, in Greenland and the northern parts of Labrador.

Are not the icebergs, generally speaking, floating in deep water?—Yes, they must be.

The floating icebergs are in deep water where a cable might be safely laid, nevertheless?—Yes; if you can have deep water to the shore, say, 200 or 300 fathoms, you may be quite sure that the cable will not be disturbed by icebergs.

Would not there be a risk of the cable being disturbed where it came to the shore?—That must be guarded against. If you can get it to the shore, it must be protected in some way, so that the floe-ice cannot get to it.

CHAIRMAN.—At what depth do you think a cable would be safe from icebergs? I suppose there is some limit to the depth?—By the time

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icebergs get so far south, they are seldom more than 150 feet above and 150 fathoms below the surface of the sea.

Mr. STUART WORTLEY.—As soon as the iceberg floats, the cable is safe, I presume?—Yes, if it is at the bottom.

Admiral AUSTIN.—If you have shallower water to the northward, it is reasonable to suppose that the cable would be safe, the ice drifting south.

Admiral FITZROY to Sir J. Ross.—Has it occurred to you that all these fiords are comparatively deep in the middle; that at each point of the fiord there is a projection of rock or land, and that no iceberg, in passing by it afloat, can touch the bottom of the fiord, because it must go over the shoal which booms it off, as it were, to a distance; it would pass from point to point, in drifting down, and must leave the hollow bottom of the fiord untouched?—Yes, of course.

Another matter has, I dare say, occurred to you, that while an iceberg is afloat, it does not carry up anything from the bottom with it? No, it ploughs deep grooves in the bottom as it passes along.

Not, I think, as long as it is floating, and not touching; the moment it moves it would separate from the bottom. If a cable is lying on the bottom the iceberg is but pressing it down for a time, the moment that iceberg floats it rises, and then it drops the cable; there is nothing of an adhesive nature in ice. When once afloat it passes on without moving the cable. If, then, the fiords have spurs on each side, and a drift of ice passes along the shore from spur to spur, being boomed off, as we should say, by these projections, there could be no injury to anything lying at the bottom. These fiords almost invariably are filled with silt or detritus of some kind, and have a safe way out to sea. You are probably aware that Americans have lately been examining these fiords at the south part of Greenland with a special object, and that the report made by the officer in charge of the vessel is that he has found no difficulty whatever in taking a cable or a telegraphic wire up the middle of these fiords. He does not allude to the question of ice floating or grounding, but he simply states the fact that he finds it easy to take a line up the middle of these fiords. I would ask you, having seen these places, whether the idea that the bottom of the fiords would be safe as a place of deposit for a cable is inconsistent with your practical knowledge of them?—I do not think that any cable would be safe where there was a liability for the icebergs to ground; the bottom of the iceberg is not always smooth; sometimes there are large hooks or prongs at the bottom, which would catch hold of anything; they go scraping along the ground, and would carry the cable away.

Admiral AUSTIN.—They are also subject to turn from the effects of the tide or weather making them lighter.

(To be continued.)

SCIENTIFIC AND ANALYTICAL CHEMISTRY.

Report on a Memoir of M. LAMY, *relating to Thallium*,* *by* M. DUMAS.

AT the origin of human societies, the arts of procuring fire at will, of cultivating corn, and of extracting metals, were considered so great benefits, that the inventors of these arts were ranked among the gods.

At the present day the metals are so numerous, that the discovery of a new simple body of this class is less astonishing to ordinary men, although the scientific interest attaching to the discovery has not at all diminished. So far from that, in proportion as new metals are pointed out, the characters which appertain to them throw, by comparison, a strong light on the characters, similar or opposite, which are found in the older metals.

As soon as the bold and felicitous labours of Bunsen and Kirchhoff had shown, beyond doubt, that, in studying natural products by spectrum analysis, it was possible to discover traces of metals which ordinary analysis was powerless to recognise, rubidium and cæsium were considered by all chemists as only the two first terms of a long series of new elements. Every one understood that the residues of manufactures, in which, by the elimination of known and useful products, were concentrated the inappreciable traces of useless and unknown substances that the matter originally worked sometimes contained, offered a mine worth exploring.

It was, therefore, natural enough that Mr. Crookes in England, and M. Lamy in France, should submit to spectrum analysis the products of the combustion of iron pyrites, which for some years have played such an important part in replacing sulphur in the manufacture of sulphuric acid; and it is easy to understand, when one has seen it, that the beautiful green line produced in the spectrum by the new body which forms the subject of this report, could not have escaped the observation of either the one or the other.

But, in our opinion, it is neither the process by which the new metal was recognised, nor the material which furnished it, that commends it to our notice. Spectrum analysis has completed its proofs, and manufacturing residues have long since been recognised as fruitful mines to explore. But thallium is destined to mark an epoch in the history of chemistry by the astonishing contrasts exhibited between its chemical characters and physical properties. It is no exaggeration to say that, in regard to the classification generally accepted for the metals, thallium offers an assemblage of contradictory properties which entitles it to the name of a metallic paradox—the ornithorincus of metals.

We shall not detain the attention of the Academy on the history of its discovery. No one disputes that Mr. Crookes first saw, on the 30th of March, 1861, the green line characteristic of thallium in certain selenium residues; that he recognised it again in the products of a specimen of sulphur from Lipari, and in those of a pyrites from Spain; and that he described and named thallium as a new simple body.

Nor will any one dispute that M. Lamy was the first to isolate thallium, and establish, in the sequel, that it was not a metalloid analogous to selenium and tellurium, as Mr. Crookes, who had never obtained it free and pure, thought; but that it was, in fact, a true metal. M. Lamy announced his discovery to the Société Impériale of Lille on the 16th of May, 1862; and on the 10th of June he submitted to the jury of chemists in London, in the presence of Mr. Crookes, a beautiful ingot of thallium. If the latter gentleman considered that he had any rights to preserve, he should at once, as is usual in such cases, have taken the members of the jury to his laboratory, and exhibited his notes and his products, instead of silently listening to the communication of M. Lamy, and depositing at the Royal Society, eight days afterwards, a note indicating that he had long been aware of the metallic nature of thallium, and was acquainted with the essential properties of the new body.

The historical point which engages us—for, in chemistry, the discovery of each new simple body has its legend or its history—is determined by two authentic dates: one of these is the 30th of March, 1861, on which day Mr. Crookes announces the existence of a new body, which he believes to be non-metallic, characterised by the brilliant green line; the other is the 16th of May, 1862, the day on which M. Lamy makes known the metal as a metal, and who alone possesses it.

It was in the sulphuric acid manufactory of our learned *confrère*, M. Kuhlmann, among the sediment of the leaden chambers fed by Belgian pyrites, that M. Lamy discovered thallium in tolerably large quantity, and in a form which made it easy to extract; for, by a little manipulation, it could be brought to the state of sulphate or chloride, from which combination the metal itself can be easily separated by means of zinc, which takes its place, and precipitates it in crystals, in the same manner as lead.

The Academy will permit us to draw attention to the importance which attaches, in cases of this kind, to positive characters, like those given by spectrum analysis. We shall see, as we proceed, that, beyond his certain conviction and natural penetration, a sure guide was necessary to M. Lamy, to prevent him from going astray in the first steps of the study. In fact, if the green line had not been there to prove incessantly that he was not dealing with lead or a plumbiferous alloy, how many chemical reasons were there for thinking that such was the fact! This metal, which is separated like lead from solutions of its salts by means of zinc, presents the appearance of lead. It has nearly the same colour as lead; is scratched and cut like it. It makes a streak on paper like that which lead produces; it has the same density, and very nearly the same melting point. It possesses the same specific heat. Its solutions are precipitated black by sulphuretted hydrogen, yellow by iodides and chromates, and white by chlorides, just as those of lead are. We do not, then, hesitate to assert that, without the aid of spectrum analysis, this curious and important metal must have remained unrecognised; that, even with this help, it was easy to be mistaken; and that M. Lamy has given proofs of great sagacity, when he places, without hesitation, a metal so much resembling lead in its essential properties beside the alkali metals, potassium and sodium, which it resembles so little.

Thallium is a perfect metal, endowed in the highest degree with a metallic lustre, as is seen on examining a freshly-cut surface, or on heating a bar strongly in hydrogen, and allowing it to cool in that gas. It is less blue than lead, less white than silver, and, in its colour, more resembles tin or aluminium than any other metal. It softens at 100° C., and, if kept for some time at that temperature, a crystalline structure becomes apparent in the ingot: this is shown by the appearance of a beautiful watering (*moiré*), produced when the metal is moistened with water, which cleanses the surface like acids.

Before the blow-pipe, thallium exhibits some characteristic phenomena. It melts rapidly, and oxidises, giving off odourless fumes, of a whitish colour, but mixed with reddish or violet tones. It continues to give off the fumes a long time after the heating has ceased. When the principal globule has cooled, it is found to be surrounded with small globules of the volatilised metal. In a closed tube, it melts in the flame of a spirit-lamp, oxidises rapidly, giving an oxide which, when hot, calls to mind the appearance of rubies (metallic sulphides), and which, when cold, more resembles litharge: this is a compound of the protoxide of thallium with the silica of the glass. A globule of the metal, heated over a spirit-lamp, in a bulb tube open at both ends, and inclined to facilitate the passage of air, soon melts, forming a layer of the ordinary brown fused oxide, but, at the same time, giving off abundant fumes, which condense a short distance from the bulb as a reddish or violet amorphous powder. When a globule

* *Comptes-Rendus*, lv. p. 866.

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of the metal is placed on a cupel heated to redness, and then plunged into oxygen, the metal burns brilliantly, and oxidises, the fused oxide sinking into the cupel. This oxide is either the peroxide of thallium, or a mixture of the proto and peroxide of thallium.

M. Lamy has discovered that thallium forms two oxides; the protoxide, a strongly alkaline base, like soda and potash; and the peroxide, which gives up oxygen when heated with strong acids, and may be converted into a chlorine, which, when heated, gives up a part of its chlorine. Chemists, however, will notice, that the protoxide of thallium, which corresponds to potash, so far from having, like potash, a great affinity for water, loses its water readily when heated, or even when cold in a vacuum. There then remains the reddish anhydrous oxide, while the hydrated oxide is yellowish white; the oxide is hydrated or dehydrated with equal facility. It will be further remarked, that the peroxide of thallium, in the experiments of M. Lamy, has given no sign of the formation of oxygenated water.

Thallium burns in dry chlorine. It forms three chlorides, one of which corresponds to common salt, another to sesquichloride of iron, while the third is a bichloride corresponding to corrosive sublimate. The protochloride is white, fusible, slightly soluble, and, when prepared in the moist way, is precipitated in large dense flocculi like chloride of silver. Thallium can also form higher chlorides than the bichloride, but their composition is not definite.

The proto-iodide and proto-bromide only have been studied; they resemble the corresponding compounds of lead. Cyanide of thallium is soluble; but a crystalline precipitate of this salt is formed when concentrated solutions of cyanide of potassium and of a salt of thallium are mixed.

The sulphide of thallium obtained by precipitation is brownish black; it resembles sulphide of lead. In whatever way obtained, it easily oxidises in the air, and is converted into the soluble and colourless sulphate.

Thallium is very slowly attacked by hydrochloric acid, even when concentrated and boiling. It is, on the contrary, rapidly attacked by nitric and sulphuric acids. The latter, concentrated and hot, dissolves it with a rapidity which contrasts with the slowness with which the same acid attacks lead.

In relation to the action of acids, thallium presents a complete opposition of characters to aluminium, the latter being quickly dissolved by hydrochloric acid, which does not attack the former, and resisting nitric acid, which easily dissolves thallium.

In the state of protoxide, thallium forms solution and crystallisable salts with carbonic, nitric, sulphuric, and phosphoric acids. The carbonate is a very characteristic salt.

The salts formed by the protoxide of thallium with organic acids, which have been studied by M. Kuhlmann, jun., are the oxalate, binoxalate, tartrate, paratartrate, malate, citrate, formiate, acetate, and some others of less importance. All these salts are soluble, and, according to M. La Prevostaye, some of them are isomorphous with the corresponding salts of potash.

Thallium, then, is a new metal well characterised. It is distinguished from all other reputed simple bodies by the beautiful green line it gives in the spectrum, and which corresponds to the line 1442, in the typical spectrum of Kirchhoff. From the examination of the solar spectrum, we may conclude that thallium does not exist in the solar atmosphere.

Thallium, undoubtedly, forms one of the family of alkaline metals, the number of which has been doubled by recent discoveries. At the beginning of this century, only two of these metals were known, potassium and sodium. Forty years ago lithium was added to the number; and within the last three years three others have been discovered—rubidium, cæsium, and thallium—all three by spectrum analysis.

From this we may be allowed to hope that the number of these metals, and of metals in general, is destined, by the application of this new method of analysis, to receive a rapid and considerable extension.

Among alkaline metals, thallium occupies the opposite extremity of a scale of which lithium forms the first term, and the equivalent weights mark the different degrees. The weights are, in fact, as follows:—

Lithium	7
Sodium	23
Potassium	39
Rubidium	85
Cæsium	123
Thallium	204

On this point it has been remarked,—

1. That the equivalent of sodium is exactly the mean of the equivalents of potassium and lithium, $\frac{39+7}{2} = 23$;

2. That by adding double the weight of sodium to the weight of potassium, we obtain the weight of rubidium: $46+39=85$;

3. That by adding twice the weight of sodium to twice the weight of potassium, we get nearly the weight of cæsium: $46+78=124$;

4. That by adding double the weight of sodium to four times that of potassium, we obtain nearly the equivalent of thallium: $47+156=202$.

These considerations are of a nature to attract the attention of chemists; and without attributing to them a value that the actual numbers would not justify, they show the interest which attaches to the careful comparison of the equivalents of bodies belonging to the same family.

The alkaline metals have this peculiarity, that to bring them under the law of Dulong and Petit—that is to say, to make their atomic heats equal the atomic heats of other metals—it is necessary to halve their atomic weights. Thallium does not escape this rule. Its equivalent = 204; but its specific heat, as determined by M. Regnault (who appends a note on this subject to this report), being equal to 0·03355, it is necessary to reduce the atomic weight to 102. In the same way as potash has for its atomic formula K_2O, the protoxide of thallium would have for its formula Th_2O.*

The atomic volume of thallium will be equal to 8·5; and if we do not compare it with the volumes of sodium and potassium, it is because these present extraordinary anomalies which have not yet received sufficient attention from chemists.

In conclusion, we may remark that the series of alkaline metals actually known contains a body which possesses so light an equivalent that it may be placed near to hydrogen—that is to say, lithium; and also a body, thallium, which has so heavy an equivalent that it may be ranked by the side of bismuth, a metal which possesses the highest of equivalents.

We see that the discovery of new bodies extends the circle of our knowledge, not only by the facts with which they enrich practical science, but especially on account of the prospects revealed by the study of them, the laws they lead us to ascertain, and that freer and more general aspect under which we are taught to regard the properties of individual substances, their analogies, differences, and classification, and even their nature and essence.

For those reasons, and taking into consideration the difficulties overcome by the author, the clearness and importance of his results, we have the honour to propose to the Academy that his memoir form part of the "*Recueil des Savants Etrangers.*"

THE SARDINIA AND SICILY TELEGRAPH CABLE.

To secure a more immediate and closer connection with Sicily and Southern Italy, and to have a route for the Indian telegraphic traffic other than that through the disturbed district of the Calabrias, the Italian Government decided to lay a cable from the south-west part of the Island of Sardinia, near Cagliari, to a point in Sicily between Trapani and Marsala; and Messrs. Glass, Elliot, and Co., the well-known contractors for submarine telegraphs, engaged to make, lay, and maintain, a submarine communication between those places.

The main cable consists of a seven-strand copper wire, covered with three coats of gutta percha and three of compound to a diameter of three-eighths of an inch, then served with tarred yarn, and closed with 14 No. 10 gauge best charcoal bright iron wire. Its weight in air is two tons per nautical mile, with a specific gravity of 2·68, and it bears a strain of nearly seven tons. The shore end is the same core, served with tarred yarn, and closed with 12 No. 2 gauge best annealed iron wire. It weighs seven tons per nautical mile, and will bear a strain of about 20 tons.

The screw steamer *Hawthorns*, 1,000 tons burden, which has just completed the Zaudvoort cable for the same firm, having had an iron tank 24 ft. in diameter and 14 ft. deep fitted in her, and the cable coiled into it, left Greenhithe on the 5th of December last, and arrived at Cagliari on the 17th. Mr. Canning joined her on the 22d, having travelled by Turin, and after several soundings had been taken along the proposed route, and waiting for favourable weather, on Monday, the 29th of December, at 11 A.M., the end was landed at Porto Gionco, a little to the northward of the Cavali light, Cape Carbonara, where there was a fine sandy beach, and deep water half a mile from it.

The paddle war steamer, *Malfutano*, had been detailed by the Italian Government to pilot the course, as the compasses of a ship paying out cable cannot be relied upon, owing to the constant changing of the mass of iron cable on board, and to assist the *Hawthorns*, in case it was required. The captain of the *Malfatano* having some further soundings to take, left on the 28th of December, having notice that the work of laying would commence on the following morning, if it was fine. Accordingly, at 2 P.M., with a smooth sea, the *Hawthorns* began paying out, although the *Malfutano* had not returned, as a fine day could not be risked, owing to the weather being so very changeable and boisterous at this season. After three miles of the heavy shore-end cable had been laid (depth of water 150 fathoms) the change was made to the main cable, and the course set S.S.E., to bring the cable into the shoal water north of the Keith Reef, on the Skerki,

* Mr. Crookes, the editor of the *Chemical News*, has pointed out the symbol "Th," has already been adopted for the metal Thorinum, and gives Tl. for that of Thallium. We must refer to the *Chemical News* those of our readers who may be interested in the question of priority of discovery in regard to the latter metal.

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or Esquerquis Bank, distant 100 miles, after which it was intended to steer E., until abreast of the island of Maritimo.

This course was selected, as accurate soundings have been taken on it at various times by the English Hydrographical Department, and no one but those actually engaged can appreciate the full advantages of laying a cable over a route which has been thoroughly and carefully sounded.

At daybreak next morning a buoy which had been placed on the Keith shoal ought to have been in sight. The ship, during the night, went about six knots, and it was very interesting to note by the varying indications of the dynamometer the different changes in the depth. From 9 p.m. on the 29th to 2 a.m. on the 30th the greatest depth was met with, and at 11 p.m., in the middle of it, a bark gave great anxiety by constantly crossing the bows, and keeping abreast of the *Hawthorns*, curious to know what was doing with so many lights about the ship. Had she known the trouble she was causing she would no doubt have altered her course. It is a pity that the excellent arrangements of the Board of Trade, for the protection of telegraph ships when engaged with cables, are not better known among shipping, as a cable ship, when at work, is unable to go out of her course without great risk and danger to the cable.

The regulations are:—"That a telegraph ship shall, when at work, carry at night two bright red lights, hung vertically below the white light at the foremast head, each of the intervals between the lights to be four feet. By day—two opaque black balls hung vertically from the foremast head. The lower ball to be four feet from the upper, and each ball to be three feet in diameter."

At midnight a steamer was sighted, apparently brought up; the *Hawthorns* sent up a rocket, hoping it was her lost consort, the *Malfatano*, but no reply was received.

At 8 a.m. it was found by observation that the ship had been out of her course. A sounding gave 150 fathoms, sandy bottom: and the ship was headed to the eastward. At noon it was found that the ship had been carried by the very uncertain currents which prevail here between 14 and 15 miles to the south-west of the arranged course, and also that there was not sufficient cable in the ship to reach the destination. "Imray's Sailing Directions for the Mediterranean," at page 140, speaking of the Skerki Bank, &c., says:—"The currents running so strongly, and without any positive direction, render this part of the Mediterranean extremely difficult to navigate," &c.

At 12·30 p.m. the island of Maritimo was sighted, distant by observation 43 miles, and Mr. Canning decided to run the cable into shoal water there. Setting the course for Maritimo direct, it was found that more currents were running; but, having the island in sight, the helm was altered accordingly. At 3 p.m. there was a heavy and increasing swell. At 7 p.m. the ship was abreast of Maritimo, and as the wind and sea were increasing, with signs of bad weather, the end of the cable was sealed and buoyed about 1½ mile from the shore, in 60 fathoms water, and the ship stood off and on until daylight, intending to land the end; but next morning it blew a gale of wind, and she went for shelter to Farignano, where the *Malfatano*, her intended escort, joined her, and both steamed into Trapani to wait answer to a request transmitted through the cable to London, that the surplus Malta and Alexandria cable, which was landed at Malta in September, 1861, might be used to complete this work.

On Saturday, January 3, the *Hawthorns* left for Malta, shipped the extra cable required, returned here, and after waiting for fine weather until January 12, it was thought a fine day had been secured. The end of the cable was picked up, the splice made, and paying out recommenced, but the ship had not gone many miles before she met a very heavy short beam sea, making the proposed landing-place a lee shore. At 10 p.m. it was very dark, with a low shore and reefs about the *Hawthorns*, so she let go her anchor. At daybreak she ran within a mile of the landing-place, but, as there were too much wind and sea to trust the boats in landing the end, the cable was cut and buoyed.

In England we hear about the beautiful smooth sea that is always to be met with in the Mediterranean at this season, but unfortunately this is not the case. You do get a very fine day now and then, but it changes very suddenly, and a nasty sea soon gets up.

The sea on Wednesday was really smooth, and the *Hawthorns* appreciated it, for the cable had to be carried by her raft of boats over very shallow water to the landing-place. At 4 p.m. the end was put into an old Saracenic tower called Torre Nubia, distant about one and a half mile from Trapani, and 12 from Marsala. A message from the agents of the Italian Government, who were on board during the operations, was sent through the cable, *viâ* Cagliari, to the Director-General of Telegraphs at Turin, announcing the successful completion and the very satisfactory state of the tests.

The electrical arrangements during the paying out of the cable were superintended by Mr. C. V. de Sauty, and were similar to those used in the Algerine, Corsican, Malta, Wexford, Zaudvoort, and previous cables, and everything went well during the work.

The cable has from the first tested very well; it has slightly but steadily improved during the process of immersion, and from the final tests there is every reason to hope this will be a permanent and lasting cable. The length payed out was 211 nautical miles.

It could have been wished that a cable with a less specific gravity had been chosen for the depths which were encountered in this route, as, unless careful experiments are previously made to determine the proper materials with which the cable shall be constructed, having a due regard to the depth of water and the strength of the cable, the risk of successful immersion, and of its permanent durability is very materially increased.

The paying-out machinery was designed by Messrs. Canning and Clifford, and is the same as that used by them in laying the cables before mentioned. It worked well and smoothly.—*Times.*

THE ATLANTIC CABLE.

IT becomes us to treat with all respect and deference the proceedings of so justly eminent a body as the Royal Geographical Society; and even the eccentric notions of an individual member, howsoever isolated, are not to be lightly esteemed. To the existence of such societies this country is not a little indebted for the greatness it has attained to in science, art, manufacture, and, we may add, successful colonization; bidding fair to realise the impression most flattering to Englishmen, fo the ultimate universal predominance of the Anglo-Saxon race, and the good old English tongue; which, although not considered sufficiently polite to be spoken by the honeyed lips of the *elite*, except by sufferance, is, nevertheless, part and parcel of our expressive demonstrativeness, and the true and only exponent of John Bull's pluck, promptness, and pushing perseverance.

But there is no unmixed good in the world (at least, I know of none), and hence even eminent and celebrated societies may sometimes become, perhaps unintentionally, obstructive. It is highly necessary we should know as much as possible about the bed of the Atlantic before we risk the irrevocable submersion of half a million of hard cash in a telegraph cable; but we are doubtless comparatively safe in assuming that the plateau between Galway and Newfoundland is very favourable for the purpose, from the information already acquired; indeed, had we always waited for the results of that minute survey of ocean beds, recommended by Dr. Wallich, it is a query if we could now have pointed with conscious pride to the gratifying fact of even one successfully-laid cable, while the advantages supposed to accrue from this familiar acquaintance with Old Neptune's domain, in securing uniform success, and obviating one important but suppositious cause of failure is, to say the least, dubious.

To members of the Royal Geographical Society, and a great many ordinary people besides, I doubt not that this subject of the conformation of sea bottoms is of more importance than anything else in its relation to submarine cables. Our knowledge in this direction is of necessity extremely limited and superficial, and will doubtless remain so long after deep-sea cables, of almost any length, have become an established fact. Nevertheless, I am disposed to think that in extreme depths the bottoms are of a soft, easy, and uniform nature, and that the existence of sub-alpine ranges of mountains, rocky proclivities, and such like, are to be found only in the fertile imaginations of speculative theorists. Of course, in moderate depths and shallow waters, rocky bottoms doubtless exist, together with antagonistic forces which will ever prevent a cable remaining in absolute repose; and in nearing some coasts where the descent is abrupt and steep, ledges of rock may be expected, upon which a cable will unquestionably be subjected to considerable abrasion; but then these are circumstances which are calculated for and provided against by the massive mail armour with which such portions of a cable are protected. Evidently the question we have to do with is that of deep-sea cables, and the fact of the unanimity of all practical seafaring men in recommending light cables for this purpose I take to be confirmatory of the assumption that the extreme ocean depths are favourable to the deposition of a cable, and that even should there be a rocky or uneven bottom, no disturbing forces would cause the cable to suffer by friction on thin inhospitable protuberances; hence it would remain in a state of perfect quiescence, recumbent, and partly buoyed up on the imperceptibly undulating flood.

But while I would by no means underrate the importance of as thorough a knowledge as possible of the nature of ocean plateaus, I am at the same time bound to protest emphatically against an undue

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prominence being given to that which, after all, is but a secondary matter. Dr. Wallich, and every member of the Royal Geographical Society, as well as the public generally, ought to know by this time that the construction or manufacture of a cable is, in every sense of the word, *the* question of most importance; and, next to that, its proper submersion in something like a common sense, reasonable, and nautical manner; for, doubtless, all past failures are to be attributed either to wretchedly careless manufacture, or to the preposterous method of paying out; nor can a single instance be adduced in which the character of the sea bottom contributed to failure. And until these two questions of unexceptionable manufacture (combining with the best workmanship the most suitable materials, in accordance with acquired scientific knowledge), and an improved method of submersion, are generally comprehended and insisted upon, our successes in submarine telegraphy must ever remain moderate, and far from commensurate with the advances made in electrical science and manufacturing skill. We must not be told, with all the flourish of oratory, that "recent improvements in the science of telegraphy" have been taken advantage of in whatever cable is made, unless the truth of such assertions can be demonstrated by actual fact. This is one of those matters in which faith cannot take the place of reality. If a man may be cured of a deadly malady by means of a large infusion of the former specific and rolled up bread crumbs, the same will not hold good in the manufacture of a cable. We will take no man's word upon trust, nor place our faith in a cable, which, while reputed to combine in its structure advanced scientific knowledge, proves to be in reality but an utter repudiation of the first principles of the "recent improvements," to which it lays claim; since we do not choose to indulge in a false faith, however agreeable, which can only end in miserable disappointment.

It is gratifying, however, to find that the Atlantic Telegraph Company, at least, evince a disposition to profit by the "recent improvements in the science of telegraphy;" let us implicitly trust that this will not be after the fashion of those who decided upon the construction of the Persian Gulf cable; and as we are fain to take upon grateful trust all the promises made in this instance, and are bound to believe in the sincerity of the Board that makes them, it is to be reprehended, nay more, condemned, that anything should be said or done in any quarter that should retard so desirable and imperative a consummation as the telegraphic bond that shall unite the two hemispheres, even though it should unwittingly emanate from so celebrated an individual as Dr. Wallich, or the proceedings of a body so justly eminent as the Royal Geographical Society. We have before observed that the construction of a submarine cable is *the most important* concern; and this promises to receive due consideration in all future undertakings of this sort. With respect to the projected Atlantic cable, the tenor of the address of Mr. Stuart Wortley, at the meeting lately held at Liverpool, is a guarantee that this will not be lost sight of, but, on the contrary, is esteemed of the greatest and most primary importance. It may certainly be said, and, doubtless, with some degree of truth, that a man will make fine promises on behalf of the interests of a company in adversity, which would probably be very conveniently forgotten when the possibles are fully realized that should enable such a company to bluster in the sunshine of independent prosperity. And when it would suddenly be remembered by the Board that such and such a firm or person had some claims upon their consideration, to benefit whom were indisputably more an act of friendship for old acquaintance sake, and by no means warranted, if a due regard to the interests of the shareholders be observed. Of course, this is an event which we should hardly be justified in classing with the improbabilities, providing steps are not taken which shall necessitate the rigid performance of all that it is the interest of one party to make and the other to demand.

That the Atlantic cable will be a reasonably light one we may surely assume on such excellent authority as that of Mr. Stuart Wortley; indeed, this company must perforce conform to the popular verdict, endorsed as it is by the best practical testimony we have to rely on, if they ever expect to get the funds necessary for the performance of their work; but we must do them the justice of assuming that they have really advanced with the times, that their eyes are fully opened to the rocks and shoals upon which they foundered before, and that this will be a good cable embracing all the "recent improvements," not only because it is necessary to have it so in order to raise the requisite capital, but also because the Board of Directors, together with others foremost in its ranks are so far practicably acquainted with the subject as to secure this desideratum at all risks.

But, notwithstanding all that has been written upon the manufacture of submarine cables, it is yet to be lamented that the subject is still but very imperfectly understood, and that it does not by any means occupy that position in the estimation of thinking men that they are bound to give it. It is notorious also that very few persons really comprehend the first principles of a good and effective cable, even among individuals of whom we should be justified in expecting a more advanced experience. Whereas a subject of such moment should certainly be mastered by every man who invests five pounds in the venture, in order that he may be able to judge as to the prudence or otherwise of the investment. Why should it have to be reiterated over and over again that the best cable is the cheapest, because it is the safest, and that there is no middle course in these matters between absolute success and ruinous failure? And yet it may be safely assumed that the bulk of Submarine Telegraph shareholders are totally ignorant on these all-important points, and that the other part, with here and there an exception, possess a knowledge of the most superficial kind, and therefore as practically useless to them as the total ignorance of the others. As an instance of the prevailing ignorance, it will be found that whoever writes upon the subject of insulated wires (apart from the recognized organs of telegraphic science), gutta percha is invariably spoken of as *the* insulator, as though there were no other insulating substance in creation applicable to the case; and if it should chance that caoutchouc be named as a substitute, it is merely mentioned incidentally, as though a speculative curiosity wrapped in considerable doubt, and by no means to be depended on. We shall scarcely be considered as using too strong language if we call this the most gross and inexcusable ignorance. Why, if shareholders were alive to their own interests, they would reason in this way:—

"Gutta percha may be an excellent insulating material, and may possibly answer the purpose as an efficient envelope for the conducting wire; but if it be true that the most perfect insulator is that which possesses a minimum conductive and inductive capacity, and so provides against an unnecessary waste of the electrical charge, that is the material to use, providing it is in every other respect qualified. And if, further, it be true that a coating of india rubber is equal to a gutta percha coating of double its thickness, it is manifest that the former is the material which should form the core of a submarine cable, whether looked at from an economical, or scientific, or any other point of view."

Now, if shareholders were to reason after this manner, there is but one conclusion to which they could come, and that is, they would utterly abjure all connection with any and every company who would not have their cables constructed on sound, economical, and scientific principles; and thus, having the power in their hands, they would infallibly be the means of accomplishing a desideratum very much needed. Doubtless such matters want to be made as easy as the big alphabet in a child's primer; for, if a man were told, by way of illustration, that in the passage of water, or any other liquid, through a pipe, it were better to have a pipe that would do the work without waste, than one that would show a considerable per centage of it; he would then probably understand, in part, the difference between insulation by means of gutta percha on the one hand, and caoutchouc on the other.

The Atlantic cable, as is well known, will be the longest that has ever been submerged in one unbroken length; and this, in the estimation of not a few, is held to be its greatest objection; and it would be idle to disguise the fact, that herein will lie its source of weakness, unless constructed upon the soundest principles, and in accordance with the most advanced telegraphic experience of the day. If this be secured, then the arguments of its detractors fall to the ground, for their objections are purely chimerical. The "recent improvements in the science of telegraphy," however, cannot safely be ignored in this case with that nonchalance and impunity which characterize the present operations of the Indian Board; it will not do here to lay claim thereto by word, and abjure the same in fact. If this cable were to be laid in sections of some two hundred miles or so, probably this prevaricating course might be taken with some prospect of success. But, for one vast length to span the entire Atlantic, it is a serious business, and must not be risked for the crotchets of any man, however eminent, nor for the interest of any other, how dear soever that existing friendship may be; much less must motives infinitely lower be allowed to militate against its success.

The words of the Chairman of the Atlantic Telegraph Company are re-assuring; it will be a *light* cable; they are under bondage to no man; nor are they bound to any firm for the manufacture of their cable; it will be submitted to the widest competition; the consulting engineers chosen consist of the most eminent practical electricians and telegraph engineers of the day; although, unfortunately, their views on some of the most important points are as wide as the poles asunder. And yet, after all, we have some misgiving that there will be a

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repetition, in its manufacture, of some of the most objectionable points of the old cable, unless intending shareholders are on the alert, and secure their exclusion by salutary stipulations. For instance, what proof have we that the core will not be a gutta percha one as before? True, Mr. Stuart Wortley was a member of the Committee appointed by Government on Submarine Cables, and tacitly gave his consent to the doctrine, that india rubber is by far a better insulator than percha, but he has since chosen to disavow the creed. Let us hope, for the sake of consistency, that he has again recanted. Pending, however, the gathering together of the requisite capital, we think it quite necessary and desirable that full particulars of the description of cable decided upon should be given to the public, in order that intending shareholders may have time and opportunity of judging of its merits; and, if in accordance with the general wish and expectations, who knows but that it may facilitate the work by the rapid appropriation of the shares to be disposed of? M.

THE TELEGRAPH TO INDIA COMPANY, LIMITED.

WE place before our readers this week an instructive document, "The Report of the Directors of the Telegraph to India Company." This company was formed for the "special object of utilizing the cable laid down by the Red Sea Company from Suez, by Aden, to India." The attempt proved a complete failure with the exception of the recovering of some 200 miles in length between Suez and the Island of Jubal. That short line, in a previous report, was stated to yield some £7000 per annum. We are now informed that the "Directors have found it necessary to discontinue for the present the station at Jubal," and mark the reason why. It was "on account of the risk which was considered by the Peninsular and Oriental Steam Navigation Company to attend their vessels calling for telegrams." Was it not partly also in consequence of the difficulty in maintaining the line in working order, in consequence of its imperfect, and even as it is alleged, rotten condition?

The land line between Suez and Alexandria has been leased to Messrs. Glass, Elliot & Co., for four years, at a rental of £2,500 per annum, leaving therefore the whole of the notorious Red Sea line in the same condition as it was before the Telegraph to India Company's expedition started from our shores. The following is a copy of the company's report to be submitted to the proprietors at the second ordinary general meeting of the company, on the 3rd February, in the present year:—

REPORT.

"The shareholders were informed at the late special general meeting, on December 12th, that the Government had decided to retain in their own hands the construction of the Persian Gulf line; and that under these circumstances the directors recommended the shareholders to maintain and work their Egyptian line, and to await the result of the completion and working of the Persian Gulf line, before deciding upon the course to be pursued.

Since that period the directors have found it necessary to discontinue, for the present, the station at Jubal, on account of the risk which was considered by the Peninsular and Oriental Steam Navigation Company to attend their vessels calling for telegrams. Under these circumstances the directors considered it the best course in the interests of the company to make arrangements with Messrs. Glass, Elliot, and Co., the lessees of the Malta and Alexandria cable, for working the Alexandria and Suez line for four years, from 1st January, under which the line is to be worked and maintained in good condition, without any charge upon the company, by the lessees who are to pay the company, so long as the Malta and Alexandria cable continues in working order, £2,500 a year, during the term of the lease. This will enable the board, unless any unforeseen accident arises, to pay a dividend to the shareholders during the next four years of from 4 to 5 per cent. per annum.

The board have not been unmindful of the interests of the shareholders in regard to the Persian Gulf Telegraph; they have applied for and obtained the sanction of His Highness the Viceroy of Egypt to construct a line to El Arish, with a view to completing the further communication to Beyrout, Iscanderoon, or Aleppo, and so connecting this company's line with Constantinople by one about to be constructed by the Ottoman Government from Diarbekir, on the direct line from Constantinople to India, and also by the Persian Gulf Telegraph with India, by which means a portion, and in case of accident to the direct line, the whole, of the India and China messages will pass through the company's lines.

The board consider that this short and inexpensive addition will materially affect and increase the value of the company's property; but the company having been formed for the special object of utilizing the cable laid down by the Red Sea Company from Suez by Aden to India, the board are advised that it would not be competent to this company to make the line to Beyrout. Under these circumstances the directors recommend, as the simplest means of effecting an object so vital to the interests of the company, under the circumstances which have occurred, that the branch line should be registered under the Act as a new and co-operative company, under which all the shareholders in the telegraph to India Company shall be entitled to their rateable proportion of shares. This can be done at a very small expense under the same management.

Negotiations are in progress with Messrs. Glass, Elliot, and Co., for the construction, working, and maintenance upon advantageous terms, of the proposed new line, full particulars of which will be submitted at an early meeting, to be specially convened for the purpose.

The directors have to report the arrival of the steamer *Sir James Duke*, with the cable on board.

The following directors go out by rotation, and, being re-eligible, offer themselves for re-election:—

WILLIAM DENT, Esq. CAPT. HALL, R.N., C.B.

The board have to acknowledge the continued valuable assistance of Mr. Peel, their late secretary, who, being duly qualified, offers himself for election as a director of the company."

We shall insert the company's balance sheet in our next number.

UNIVERSAL NEWSPAPER AND PERIODICAL LIST.

A VERY complete list of all the newspapers, magazines, periodicals, &c., published throughout the United Kingdom, has been published by Mr. W. Thomas, 26, Brydges Street, Covent Garden, which may often be found convenient for reference. Most of the foreign papers are also given; though in this branch we notice many omissions, such as that of the *Annales Télégraphiques*, and Poggendorff's *Annalen*. The publisher of the "Universal List" would render no small service to scientific and periodical literature by rendering as complete as possible the catalogue of foreign publications.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

TELEGRAPHIC BOOKS.

To the Editor of THE ELECTRICIAN.

SIR,—I have perused with some interest the list of electrical books, of which Mr. Clark is the owner, as, however, my library teems with volumes not included in Mr. Clark's list, I trust that you will grant me the same indulgence, as a subscriber, as you have done to Mr. Clark; upon the conclusion of Mr. Clark's list I will forward you my own. Yours, &c.

AN ELECTRICIAN.

[We consider ourselves much indebted to Mr. Clark for the opportunity he has given to our readers and ourselves of becoming acquainted with many works on electrical subjects, which might otherwise have remained unnoticed. Our correspondent will receive our best thanks if at a later period he can forward the same object.—ED. E.]

To the Editor of THE ELECTRICIAN.

SIR,—Will you be kind enough to explain the following, it would be interesting to telegraphists.

At a Telegraph Station there are about twenty instruments, all terminated as usual to *one end* of an earth wire, which is about twenty feet in length, the opposite end being soldered to the water pipes and cistern. When the instruments are at work, five or six of them may be sending copper to earth zinc to line, the others copper to line zinc to earth. How can these currents which are flowing in opposite directions, along the earth wire, pass each other to complete the circuit, or if they do not pass each other, how is the circuit completed. Yours, &c. L.

To the Editor of THE ELECTRICIAN.

SIR,—In bringing any new feature before the public, I am aware that we render ourselves open to a variety of opinions, which are often the reverse of a charitable construction. Nevertheless, a small contribution, elicited from experience, may sometimes be the stepping stone to greater development. In my profession I have, for years, handled thousands of steel magnetic points, both before and after they are magnetized. I have often pricked my fingers with these points, and I have invariably suffered less pain and a quick healing from the puncture of the steel points, magnetised than those not magnetised. I am aware that the "electric current" will make a cut very sensitive, but, on the other hand, we also know, that the "electric current" will also deaden feeling. I will simply introduce the "Phenomenon" as I have experienced it, leaving it an open question with those who feel interested in such matters—perhaps the time may come when a "magnetic knife" will be found of advantage at the operating table. But if any one is sceptical as regards the full consequence of a puncture from a steel point, magnetised or otherwise, I shall be most happy to allow them every opportunity at my office to test it, and the use of such steel points, which a small prick of the finger from each, I am satisfied, will be abundantly convincing. Yours, very truly,

JAMES SPRATT.

Inventor and Patentee of Improved Lightning Conductors,
21, Middle Row, Holborn.

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THE CABLE FOR THE PERSIAN GULF.

To the Editor of THE ELECTRICIAN.

SIR,—I have been informed, but I can hardly believe it, that the Persian Gulf cable is to be protected against corrosion, by a compound which science has taught us, from the very nature of the ingredients employed, must rapidly succumb to the action of sea water, especially after being subjected to a very high temperature, as it will be in the course of transhipment. Evaporation by heat will reduce the compound to a brittle resinous substance, and I shall be very anxious to hear how it will pass over the wheels and pullies on being "paid out." I have heard somethig of the Isle of Man, and the St. David and Wicklow cables, uselessly coated with this compound, in despite of the attempts made to conceal their mishaps. I write to you sir, with a view of preventing if possible, the utter annihilation of public confidence in submarine telegraphy. We lack no improvements, and promising ones too, but we must endeavour to remove the incubus which weighs upon the science, in the shape of incapacity, for improvement ere we can ever hope for success. P. L. T.

To the Editor of THE ELECTRICIAN.

SIR,—Is it possible that my last letter, page 275, described such a simple complete, and efficient system for signalling trains, as to effectually silence all my opponents, although you left the question open for discussion. When I first alluded to the subject in a rather obscure way, many of your correspondents compared me to a "church spire," the "mountain in labour," and many other similes, but when I brought forth a perfect plan, they had not a word to say, neither for or against the system. Perhaps the plan looks too much like a copy from Mr. Preece's, to deserve any attention, but that cannot be, as I think the system was alluded to before Mr. Preece's papers appeared in print. I beg of you to thank Mr. F. Rudall, for the able and disinterested manner in which he has laid his system of signalling trains, before your readers. Before concluding, I beg to state that I quite agree with what "Omicron" says about *anonymous writing*, and wish to ask why *he* did not sign *his* own name.—I am, sir, yours respectfully, *pro inquisitive*, O. P. S.

January 26th, 1863.

Telegraphic News.

WE are requested to publish the following letter, under authority of the Directors of the International Ocean Telegraph Company :—

To the Editor of THE ELECTRICIAN.

SIR,—The Directors of the International Ocean Telegraph Company having had their attention directed to certain observations made by the Right Hon. Mr. Stuart Wortley, on the occasion of his recent visit to Liverpool, which if allowed to pass unnoticed, might affect prejudicially their undertaking, have requested us to say, that the direction of their Atlantic line has not yet been definitely decided upon, and that the company which Mr. Wortley disposes of so summarily, will shortly be brought before the public powerfully supported, both on the Continent and England, without the burdens which attach to the company of which he is the representative.

Yours obediently, EDWARDS & Co.

8, *Delahay Street, Westminster, January* 26th, 1863.

THE ATLANTIC TELEGRAPH COMPANY.

WE are glad to find that the subscriptions towards this important undertaking are progressing satisfactorily. At the same time, we trust that other requirements for success, to be found among modern improvements, are receiving due attention.

CAPE OF GOOD HOPE.

THE progress of telegraphy in this colony is most encouraging. We have had from time to time to record the works either in progress or completed. We have now the pleasure to announce, that the construction of the telegraph from Cape Town to Graham's Town, is to be commenced immediately.

DURING the late gale, the wires of the Magnetic Telegraph Company were broken to the South of Kilmarnock, but were speedily repaired. They were also damaged to the South of Dumfries at the same time, and this mishap had the effect of stopping all communication with the south for some time.

THE wires of the Electric Telegraph Company were also damaged in several places to the south of Glasgow, and the communication stopped; but those in connection with stations north of the city were not the least injured.

THE Royal Oak, 34, iron-cased frigate, is to be supplied with Gisborne's patent electric steering and engine-room telegraphs, which the Lords of the Admiralty have ordered to be fitted on board that vessel. Mr. Gisborne, the inventor and patentee, has attended at the dockyard for the purpose of making the necessary arrangements for fixing the invention on board the Royal Oak, the new code of signals having been for some time past tried on board the paddle-wheel steamer Rhadamanthus, with the most complete success. By means of the new apparatus every order of the captain, or other officer in charge of the vessel, is instantaneously and simultaneously communicated to the helmsman and also the engineer.

Miscellanea.

ANOTHER NOVEL APPLICATION OF THE TELEGRAPH.—Reid Brothers, Wharf Road, City Road, have just completed a telegraph (Wheatstone's system) in the interior of the Pneumatic Tube at Euston Square Station. When the carrage containing the letters, parcels, &c., is dispatched on its subterranian journey, before it has proceeded twelve inches on its dark iron road, the signal has flashed at the other end of the tube to tell what is coming; and when the budget is received, the return flash says all right. This may be termed the concentrated essence of commerce.

DURABILITY OF CAOUTCHOUC UNDER WATER,—The following letter has appeared in the *Melbourne Argus* :—"Sir,—In reading an account of the diving operations made to recover the materials of the Dunbar, which was wrecked near Sydney five years ago, I noticed a fact sufficiently important to be made known thrcugh your columns. Amongst an infinite variety of *débris* of all sorts of things agglomerated together, and more or less decomposed by chemical action, there was one article absolutely uninjured by its long immersion. This was the caoutchouc made into elastic webbing, used for men's braces. The circumstance is the more interesting when it is remembered how fine are the india rubber threads of which that fabric is made. Vulcanized caoutchouc has, indeed, been recently applied as an insulating cover for cables, but no experience of its durability has been had as yet; and I should think, from its greater hardness, and less elasticity than unaltered caoutchouc, that it will be more liable to injury. It is almost impossible to file away the pure caoutchouc, and it may be inferred that it would equally withstand the friction of jagged rocks in the bed of the sea,—I am, Sir, your obedient servant,

AUGUSTUS F. A. GREEVES.

Melbourne, September 26.

To Correspondents.

M. P.—WE believe that if there were half a dozen submarine telegraph cables laid across the Atlantic, they would all yield a remunerative return upon the outlay.

X. X.—Mr. Henley's contract only extends to the external sheathing of the core, the core being manufactured by the Gutta Percha Company. Sir William O. S. Brooke, guided by experience, intended to have adopted india rubber insulation for this important line, but the wisdom presiding at the India Board has decided otherwise, contrary to the recommendation of Sir William and of the Government Committee on Submarine Telegraphy, who, in their Report, state that gutta percha is not adapted for shipment to hot climates.

AN EXPERIMENTALIST.—If you wish a permanent insulation, adopt cleansed gutta percha or india rubber. We have no faith in compounds, they only afford a temporary advantage.

O. D. L.—Our land lines have been successful, for the simple reason that they are under the superintendence of intelligent and practical men, ever ready to afford and receive information. The Malta and Alexandria Cable, from the very first day of its submersion, has never been made the object of scientific converse, even among those most deeply interested in its welfare.

L.—The currents passing in opposite directions neutralise each other, partially or completely, without completing the circuit through the earth. Supposing two batteries of equal power to be employed in working two parallel lines of wire, and to be connected to the same earth plate at each station; then, in the case you mention, the two batteries virtually become one, a zinc and a copper pole being united at the sending station. The poles of this battery of double power are also united at the junction of the line wires with the earth wire at the receiving station. Thus the circuit is entirely metallic, and its doubled resistance is overcome by a double electro-motive force. The earth wires might be cut without affecting the signals, supposing these to be sent simultaneously from each pole of the double battery. We think this will be sufficiently clear, if not, we will endeavour to make it more so.

A. H. B.—Your questions have been overlooked; we will now answer that referring to Callan's single fluid battery. The iron of your cells is evidently insufficiently carbonized to constitute an efficient negative when dilute sulphuric acid is used as the exciting fluid, although it might answer the purpose when rendered passive by the action of nitric acid. We shall endeavour to obtain reliable data in regard to your first question.

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The Electrician.

VOL. III. No. 66.—FEBRUARY 6, 1863.

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NON-INFLAMMABLE FABRICS.

IT would be difficult at the present moment to find a subject, in connection with applied chemistry, of greater popular importance than that of the preservation of life against fire. We have done much to diminish the risk of conflagration in dwellings;—what with fire engines, fire annihilators, fire-proof partitions, fire escapes, and the recent fire telegraph, we are conscious of having attained some degree of security in this regard. But, with culpable negligence, we allow women, without protest or warning, to array themselves in more dangerous attire than that of the centaur Nessus. Why, Heaven guard them, their gala dress is more inflammable than the armament of a fire-ship! The merest accident, the wafting of a skirt towards fire or candle, must expose them to an almost inevitable and agonizing death. And thus we are constantly sickened with the details of such scenes as that which was so recently enacted, partly in presence of the audience, at the Princess's Theatre. Has science no safeguard, has manhood no foresight,—no tender care, or pity, for the gentler sex among whom, almost exclusively, such tearful tradegies occur?

Men, and gentlemen, who have sisters, wives, daughters, or even others less near, to care for, science has long since found the safeguard; the remissness through which such terrible casualities occur must be traced mainly to yourselves. The maxim, *qui Deus vult perdere primum dementat*, scarcely applies to those who, to some extent at least, are under your guidance. A stronger expression might meet the case where the most needful and precious gifts of ever-wakeful science are wilfully neglected. It is time to speak plainly in this matter. Wilful neglect and carelessness may, as we know, sometimes amount to absolute guilt. This danger is too obvious to be overlooked, the remedy is too simple and inexpensive to be dispensed with, without serious fault of omission.

> "Evil is wrought by want of thought
> As well as want of heart."

In our fifth number, will be found an article under the present heading, in which the means for rendering fabrics non-inflammable is pointed out. In the *Mechanics' Magazine*, of November 11, 1859, an article appeared upon the same subject, drawing attention to the then recent researches of Messrs. VERSMANN and OPPENHEIM. This, we remember, was quoted in the *Times* and in most of the daily papers both in England and the continent. In the *Engineer* of the same date the discovery of the above-named chemists was also referred to. It is almost incredible, therefore, that one most efficient and thoroughly tested method of preventing the class of casualities we have dwelt upon should not, at the present moment, be very generally known. Yet, if we are to judge from the desultory and trifling correspondence which has appeared in several of our contemporaries, the greatest ignorance prevails in regard to what has been done by chemists in this direction. The processes recommended by Messrs. VERSMANN and OPPENHEIM were the result of a long and careful investigation, made by desire of Her Majesty, and entrusted by the Master of the Mint to these chemists. Of the many substances tested, two salts only were found perfectly efficacious for the purpose in view, viz., the *sulphate of ammonia*, and the *tungstate of soda*. Neither of these injure in any degree the material subjected to the preservative process. A solution of the former is adapted for the use of the manufacturer, who prepares his goods without contact with hot iron; the latter was recommended for home use, as, mixed with starch or otherwise, it allows the iron to pass freely over the fabric. The tungstate of soda became to some extent, and continues to be, an article of commerce. It was adopted in Her Majesty's laundry at Richmond; and the advantages attending its use were strongly insisted upon by some portion of our scientific press. Other compounds, which had been tested and rejected by chemical authorities, were subsequently introduced into commerce, and, being extensively advertised, were in many cases patronised by the public. Probably it was one of these spurious "fire-proofings" which was referred to by the supermaster at the Princess's Theatre, in his evidence given before the inquest upon the unfortunate member of the "extra ballet" lately burned to death. The effects of the solution into which the dresses are sometimes dipped were stated to last only for a week or two. This solution is, we imagine, that of the *silicate of soda*, which, though at first answering the intended purpose, soon becomes decomposed by the atmosphere. While the labours and careful recommendation of the chemist are thus disregarded, it is scarcely to be expected that adequate means will be adopted for the object in view.

Prior to the researches of Messrs. VERSMANN and OPPENHEIM, Mr. JOSEPH WILBRAHAM had been in communication with the War Office authorities relative to a means, discovered by him, whereby all textile materials employed and stored for military and naval service might be rendered non-inflammable. The process was recommended by its extreme cheapness, by the antiseptic and preservative property of the substance employed, and by the important fact that the goods might be exposed to wet, or even washed, without destroying their non-inflammable property. The adoption of the means suggested, which was not made public, was ultimately declined by the War Office on the grounds that the damage by fire of the materials it was proposed to render non-inflammable is an accident of unfrequent occurrence. Mr. WILBRAHAM then undertook a series of experiments, some of which we have witnessed, to ascertain how far this process might be depended upon for the prevention of accidents by fire through the ignition of ladies' drapery, bed-curtains, &c. We can fully testify to the fact that materials prepared by this method are most efficiently rendered non-inflammable, becoming merely charred and ultimately calcined by contact with flame, the action of which is confined to the portion of the fabric immediately exposed to its effect. By this process, therefore,—the cost of which is stated to amount to the sum of *one halfpenny per dress*—such lamentable accidents as those we have had occasion to notice would become impossible. It is necessary only that purchasers should insist upon the materials supplied for ladies' dresses, &c., being rendered in all cases uninflammable. The complaint of the inventor is that there is "no demand" for the means adapted to this purpose. This will be the case until the sense of our individual responsibility, in a matter of life and death, shall render evident the universal necessity of preventive measures against a class of accidents to which the gentler sex is specially liable.

We observe that Captain SHAW, the intelligent superintendent of the London Fire Brigade, and the promoter of fire telegraphs, has had a very narrow escape of losing his life, from the canvas bagging of a fire escape that he had mounted having become inflamed. We hope that this accident will not be disregarded, and that the most efficient chemical means will be taken to render almost impossible the destruction by fire of the apparatus employed to facilitate escape in cases of conflagration.

THE board of directors of the Electric and International Telegraph Company have resolved to recommend to the proprietors, at the general meeting to be held on the 10th instant, to confirm a dividend of £3 10s. per cent. for the last half-year.

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ON THE APPLICATION OF SCIENCE TO ELECTRO-PLATE MANUFACTURES.

(Continued from page 147.)

THE success of an important enterprise has frequently depended upon an apparently trivial circumstance, and it was even so with the important process of silver electro-plating in the early period of its development. In the year 1838, Messrs. G. R. and H. Elkington were engaged, commercially, in coating military and other metal ornaments with gold and silver, by immersing them in various solutions of those metals, some of which were composed of ferrocyanide of potassium, and also carbonate of potash, with the oxides of gold and silver dissolved in them.

By this process of simple immersion, although the action was electrical, the articles received only an extremely thin film or coating of the precious metals, and it was highly desirable that the thickness should be considerably increased, on account of the greater degree of durability required.

About this period, Professor Jacobi, of St. Petersburg (October, 1838), and Mr. Spencer, of Liverpool (May, 1839), published their processes of electrotype for copying engraved plates in copper by separate currents of electricity, by means of which a firm coating of copper, of considerable thickness, could be readily obtained. From the moment that this method of obtaining *thick* deposits of firm copper by means of a *separate* electric current was made known, Mr. John Wright, a surgeon of Birmingham, and Mr. Alexander Parkes, a modeller and experimentalist, in the employ of Messrs. Elkington, were constantly engaged in experiments, to obtain thick deposits of silver and gold by similar means. A great variety of liquids were tried for the purpose, but all the solutions of gold and silver operated upon gave only a thin deposit of firm metal, which, as it increased in thickness, became loose in aggregation, and assumed the character of a dark-coloured or black metallic powder, completely useless for the purpose required.

At this particular juncture, Mr. Wright met with the following passage in Scheele's "Chemical Essay" (pages 405 and 406). Speaking of the solubility of the oxides and cyanides of gold, silver, and copper, it says, that "if after these calces" (*i. e.*, the cyanides or ferrocyanides of gold and silver) "have been precipitated, a sufficient quantity of precipitating liquor be added, in order to redissolve them, the solution remains clear in the open air, and in this state the aërial acid" (*i. e.*, the carbonic acid of the atmosphere) "does not precipitate the metallic calx."

This liquid, "the precipitating liquor," is obtained by burning dried blood with potash in an iron vessel, cooling the melted product, and dissolving out its soluble portion by water; the resulting solution contains cyanide and ferrocyanide of potassium, the latter of which is commonly known as "yellow prussiate of potash."

Mr. Wright had been working during several months, expressly to obtain a thick deposit of silver, with the aid of a separate electric current, before he met with the above passage. He then took a solution composed of chloride of silver, dissolved in an aqueous solution of ferrocyanide of potassium, and succeeded in obtaining what had never been obtained before—a *thick* deposit or coating of *firm* silver by electrolytic action.

The first article that received the successful coating was a small vase, which was coated at Mr. Wright's residence, and the next was a figure of a small kid. The mode of proceeding adopted by him in these cases, was to place the article in the silver solution contained in a porous vessel (a common garden-pot), immerse the porous cell in an outer vessel containing dilute sulphuric acid, place a cylinder of sheet-zinc around the porous vessel in the dilute acid, and connect it by means of a copper wire with the article to be coated; the electrical action then commenced, and the article gradually acquired a thick coating of silver: this method is commonly known as the "single cell" process. It was about a month after this, when a solution of actual cyanide of silver and potassium, the substance now universally used for electro-plating, was first employed by Mr. Wright for the purpose, although cyanides, in several forms, had been used both for coppering and silvering by simple immersion, without the aid of a battery or zinc, about sixteen months previously.

The above-mentioned successful results were immediately submitted to Messrs. Elkington, who made arrangements with Mr. Wright for the security of the discovery and invention, and patented it on March 25th, 1840; this patent was the basis of all successful electro-silver-plating and gilding. A handsome remuneration was made to Mr. Wright by this firm for his invention, and an annuity paid to his widow (afterwards the wife of Mr. Cammell, of Sheffield), after his death. A separate battery, to generate the electric current, was not employed until January, 1841, nearly a year after the date of the patent; and, in the early stages of the process, the silver solution was employed hot; now it is always used cold. Nickel silver was always the substance employed as a base for receiving the deposit from the earliest period of electro-silver-plating, or, at least, soon after the date of Mr. Wright's patent. The edges of articles are made of the best quality of nickel silver, which is very white and very hard, suitable for resisting friction, whilst the body part, or mass of the article, is made of a commoner quality, not only because it is less expensive, but also because it is worked more easily.

Electro-deposition of the precious metals was *theoretically* accomplished long before cyanide of potassium was known; as early as the year 1805, Brugnatelli "gilt, in a complete manner, two large silver medals, by bringing them into communication, by means of a steel wire, with the negative pole of a voltaic pile, and keeping them, one after the other, immersed in ammoniuret of gold, newly made and well saturated." We should, therefore, not condemn theoretical science, because we are not able, even with fair and persevering trial, to apply it to any useful purpose, but *wait patiently* until circumstances ripen for its application. Many discoveries and inventions which are inapplicable in one state of knowledge, become applicable by the progress of science and art; the idea of electro-gilding, first attempted in 1805, by means of a solution of ammoniuret of gold, had to await the discovery of cyanide of potassium, in 1815, before it could be practically applied; and the idea of an electric telegraph, first attempted by the aid of frictional electricity, had to abide the development of the voltaic battery, and the discovery of electro-magnetism, before it could be successfully carried out.

A great number of experiments had to be made, and many serious difficulties to be surmounted, before practical and remunerative electro-plating was an accomplished fact. One of the chief difficulties consisted in making the silver adhere firmly to all parts of the underlying metal; this want of adhesion arose partly from the employment of too many cells in the battery, and partly from the use of too strong mercurial solution in preparing the surface, and was eventually overcome by lessening the number of cells, and dipping the previously cleaned articles in a *very weak* solution of mercury, immediately before placing them in the plating liquid. If the deposit of silver is not firmly attached to the whole of the surface of the article, it is apt to rise in blisters, and peel off when the articles are subjected to the after-process of burnishing. This non-adhesion of the silver was particularly apt to occur with articles made of Britannia metal, and with this particular alloy it was not overcome for several years; it was then effected by first coating the articles with copper, by electro process, in a solution composed of sesquicyanide of copper dissolved in an aqueous solution of cyanide of potassium, a liquid invented by Mr. Wright for the purpose of coppering articles of iron, previous to silvering them, and patented in September, 1841. The method now in use for coating Britannia metal is different; it consists in first forming a thin deposit of silver upon the article, by a powerful battery, in a solution containing but little cyanide of silver, and much cyanide of potassium, then transferring the article to the ordinary silver-plating liquid, and completing the deposit therein in the ordinary manner: this process was first employed by Mr. Thomas Fearn, from whom it was purchased by Messrs. Elkington for a considerable sum of money.

Another difficulty arose in a tendency of the deposited silver to assume a granular or semi-crystalline state upon the surface of the articles, especially at their edges, during the process of deposition; this was overcome by employing proper proportions of the ingredients in the plating solution, and carefully adapting the power of the battery to the size of the articles. In addition to these difficulties another was experienced; the articles, after being plated and finished, in a few months became much discoloured; this was a consequence of too rapid deposition. And a still more serious difficulty, which required several years to surmount, arose from the opposition of the manufacturers of plated wares, of Sheffield, to the new method of plating; they objected to take licences for the new process; but now the electric method is the only one they employ. A dispute also arose between Messrs. Elkington, of Birmingham, and Ruolz, of Paris, the latter having obtained a knowledge of the process, and taken out a patent for France a short time before Messrs. Elkington, and a trial at law resulted, in which it was established that Messrs. Elkington were the original patentees of the cyanide of potassium solution, and it was finally settled by a compromise between Messrs. Ruolz and the patentees for the use of the process. In consequence of these and other difficulties, it was at least seven years before it became both practical and remunerative.

In electro-plating, the deposited metal spreads as readily over the

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most elaborately engraved or figured surfaces as over the plainest forms, and, in consequence of this property, the new process caused a new and great extension of trade in plated articles to spring up, because articles of complicated forms, or with elaborate designs upon them, could not be made by the old method without very great expense. By the new method they were first cast of the requisite shape in German silver, and then coated with the precious metals, whereas by the old plan they required to be made from flat sheets of copper, previously plated with silver by fusion; the different parts of a complex figure were first stamped into the requisite forms separately, and then the various pieces soldered together to make the entire figure; and thus a figure which could be made entire in a single piece by the new mode, required to be formed of several or many pieces by the old one, and after a moderate amount of wear the lines where the parts were soldered together became visible, and greatly disfigured the object, and those lines could not again be covered with silver. By the old plan, every portion of a figure which was "undercut," *i. e.*, in which the external parts overhung the internal ones, such as the mouth or ear of an animal, for example, required to be made of several pieces, whilst by the new method such parts could be made entirely in one piece with the whole figure, and be coated with the precious metals all over, without any seam or joining. A great scope for the extension of beauty and taste in designs of metallic figures and vessels thus commenced, which has gradually extended itself to electro-plated articles of very moderate price, such as tea-pots, coffee-pots, cream-jugs, sugar-basins, &c., the base of which consists of Britannia metal; and the electro-process has thus enabled persons of limited incomes to enjoy the use of articles of elegant design previously inaccessible even to the wealthy.

The next event of importance in the history of electro-plating consisted in the application of magneto-electricity instead of electricity from a voltaic battery to depositing purposes. In August, 1842, J. S. Woolrich took out a patent for the use of a magneto-electric machine, instead of a voltaic battery for electro-plating. This machine, which is in use at Mr. Fearn's electro-gilding works, Birmingham, and various other places, consists of a revolving wheel, containing at its outer edge a number of short bars of soft iron, upon which are wound coils of insulated copper wires, giving to the bars the appearance of a series of reels; the wheel is surrounded by a set of powerful steel magnets, which are immovable, and fixed in a case, and have their ends, or poles, all pointing towards the wheel, so that, as the wheel revolves, each of the reels of wire with its iron core, passes in succession between and very close to the poles of each magnet. As each of these coils approaches a magnet, a current of electricity is developed in one direction, and as it leaves the magnet a current is produced in the opposite direction, and similarly with the whole of the coils. All the corresponding ends of the coils are connected with the axle of the wheel, from which the positive electricity of all the spirals is collected by a metal spring, which presses upon the axle and conveys the current onwards to the depositing solution; and all the opposite ends of wire are connected with an apparatus on the axle called a communicator or break, and this apparatus collects all the negative electricity of those ends, and transmits it to another spring which conveys it to the plating vat. And thus, by quick rotation of the wheel, a rapid succession of electric impulses are generated, which are employed for plating purposes in the same manner as the ordinary voltaic current. The above machine is a very convenient source of electricity where a cheap motive power is at command, and where the quantity of electricity required is not very great.

The surface of silver deposited from the ordinary cyanide of silver and potassium plating solution has a frosted or snow-white appearance, which, in many cases, has to be burnished and made bright by mechanical means. This, with the articles of highly figured design, and also with the interior of certain articles that required to be made bright, was a great disadvantage, as the process of burnishing is tedious, and, with the interiors of vessels, also very awkward to perform. As with the difficulty in the early period of the electro-process in obtaining thick deposits of firm silver, a little circumstance was the cause of that difficulty being overcome, so was it with this obstacle, and it happened as follows:—In the process of copying figures for electrotyping by a mixture of wax and resin, the surface of the wax is covered with a film of phosphorus by means of a solution of phosphorus in bisulphide of carbon. It was observed by Mr. Millward, at Messrs. Elkington's establishment, that when these prepared wax moulds were put into the cyanide of silver-plating solution for the purpose of receiving a coating of silver, other articles, such as spoons, forks, &c., which were being plated in the same vat, and especially those nearest to the wax moulds, acquired a coating, more or less perfect, of *bright* silver, which occurred sometimes in patches, and sometimes extended all over the articles, instead of the ordinary snow-white deposit. This circumstance attracted attention, and induced Mr. Millward to try the effect of adding bisulphide of carbon alone to the plating liquid. Considerable success soon resulted; but at this juncture the secret escaped, and in consequence thereof a patent was taken out, March, 1847, by Mr. Millward, and a person of the name of Lyons, who had acquired a knowledge of the secret for producing bright deposited silver by means of bisulphide of carbon. This process has been constantly employed ever since, and is now in extensive use, and with its aid the silver is rendered very bright, and the amount of burnishing required very considerably reduced, but it has the disadvantage of making the deposited silver much harder. Bright copper had been observed about two years before bright silver, and occurred whenever a large number of phosphorized wax moulds were put into a solution of sulphate of copper to receive an electro-deposit of copper. Other substances possess the quality of imparting brightness to deposited silver, but none in so satisfactory or eminent a degree as bisulphide of carbon: among these may be mentioned bicarbonates of the alkalies, and many organic compounds, and it is probable that the brightness depends upon a *gaseous* body being dissolved in the plating liquid.

(*To be continued.*)

THE SUBMARINE TELEGRAPH.

BY T. A. MASEY.

The following paper was read before the Society of Arts on Wednesday, the 28th ulto.

THE remarks which I have to offer this evening are more of an historical character than a scientific treatise upon the subject, and are not intended to illustrate any new principle of electric science, or to advocate any particular cable or route, but simply to place before you what has already been accomplished, and to review the various projects put forth by the different persons interested, leaving it to them, and to the *savans* in the science, many of whom I see present, to tell you, in a strictly scientific form, their views on the subject.

The invention of the electric telegraph, as it now exists, belongs not to one individual, but is the joint production of many eminent, scientific men at different periods, and of various countries. The following may specially be mentioned:—Watson, in England, 1747; Lesarge, at Geneva, 1774; Betancourt, in Spain, 1787; Sommering, in Germany, 1809; Dyer, in New York, 1820; Steinheil, in Bavaria, 1836; Sir Wm. O'Shaughnessy, in India, 1839; Cooke and Wheatstone, in England, 1837; Professor Jacobi, in Russia, 1842; Morse, in America, 1843; and Brett, in London, 1845.

But to England and Englishmen will ever belong the merit of its first practical use and development, and the names of Cooke, Wheatstone, and Brett, will ever stand out as landmarks in the history and progress of this wonderful invention, as the men who gave the lightning voice, and bade to speak, in every tongue, its marvellous messages to the world. With the names of the two first gentlemen must ever be associated the merit of having practically introduced the science of land telegraphy, and with the name of the latter, that of submarine.

Now that the submarine telegraph occupies such a prominent position before the world, many have claimed the honour of its invention, because they had been associated with it at an early date. Without wishing to detract from the merit of the labours of one individual, or to add to those of another, I may be permitted to state so far as it is known what each rival claimant did.

Professor Wheatstone, in 1840, prepared plans for a submarine telegraph, which he either did not complete, or circumstances prevented him from making any practical use of them, at that time or since.

Professor Morse states that in 1842 he laid an insulated wire across from Castle Garden to Governor's Island in the harbour of New York, and demonstrated the practicability of submarine telegraphy. His experiments, however, went no further, beyond suggesting the probability that a telegraph across the Atlantic would be some day accomplished.

The theory and experiment were destined to be practically and successfully carried out by another. Mr. Brett, in 1845, took out a patent (the first on record) for the invention of a submarine electric cable, the insulating medium to be caoutchouc and other substances (gutta percha not having come into use for telegraph purposes) protected by a plaited hempen cord, similar to that which is being advocated by several persons at the present time.

It also appears, on reference to the Government Joint Stock Registration Office, that in June, 1845, the Messrs. Brett registered a company "To form a connecting mode of communication, by tele-

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SUBMARINE CABLES.

Date when laid.	From	To	No. of Conductors.	Size per Birmingham Wire Gauge.	Size of Gutta Percha per Birmingham Wire Gauge.	Outside Wires.		Length of Cable in Statute Miles.	Length of Insulated Wire in Statute Miles.	Depth of Water in Fathoms.	By whom manufactured.	Length of time the Cables have been working.
						No.	Size.					
1851	Dover	Calais	4	16	2	10	1	27	108	...	Wilkins & Wetherly, Newall and Co., Kuper and Co., and Mr. Crampton.	11 years
1852	Holyhead ...	Houth	1	...	...	12	...	73	73	...	R. S. Newall.	... ...
1853	Denmark, across the Belt ...	... ...	3	18	4	9	2	18	54	...	R. S. Newall & Co.	9 years
1853	Dover	Ostend ...	6	16	2	12	2	80½	483	...	Newall & Co., & Kuper & Co.	9 years
1853	Frith of Forth ...	... ...	4	16	1	10	8	5	20	...	R. S. Newall & Co.	9 years
						4 cables	galvanized					
1853	Portpatrick ...	Donaghadee ...	6	16	2	12	2	25	150	...	Ditto.	9 years
1853	England* ...	Holland* ...	1	16	1	10	8 galvanized	480	480	30	Ditto.	9 years
1854	Portpatrick ...	Whitehead ...	...	6	...	...	...	27	162	...	Ditto.	... ...
1854	Sweden	Denmark ...	3	16	No. 2	10	2	12	36	14	Glass, Elliot, & Co.	8 years
1854	Holyhead ...	Houth	...	...	...	...	...	73	73	...	R. S. Newall, & Co.	8 years
1854	Italy	Corsica ...	6	16	1	12	1	110	660	325	Glass, Elliot, & Co.	8 years
1854	Corsica	Sardinia ...	6	16	1	12	1	10	60	20	Ditto.	8 years
1855	Varna	Constantinople	...	...	...	...	...	172	172	...	Newall.	7 years
1855	Varna	Balaklava ...	...	...	...	...	...	356	356	...	Ditto.	7 years
1855	Egypt	... ...	4	16	2	10	1	10	40	...	Glass, Elliot, & Co.	7 years
1855	Italy	Sicily	3	16	2	10	1	5	5	27	Ditto.	7 years
1856	Newfoundland ...	Cape Breton ...	1 strand	14	1	12	9	85	85	360	Ditto.	6 years
1856	Prince Edward's Island ...	New Brunswick	1 do.	14	1	12	9	12	12	14	Ditto.	6 years
1857	Norway, across	Fiords	1 do.	14	1	10	6	49	49	300	Ditto.	5 years
1857	Sardinia	Malta ...										
1857	Malta	Corfu ...		...	...	...	...	700	700	...	Newall and Co.	... ...
1857	Across mouths of	Danube ...	1 do.	14	1	12	9	8	8	...	Glass, Elliot, & Co.	5 years
1857	Ceylon	Mainland of India, &c.	1 do.	14	⅜	...	8	30	30	...	Ditto.	5 years
1857	Sardinia	Bona	4	...	...	...	...	125	500	...	Newall and Co.	3 years
1858	Italy	Sicily	1	16	2	10	1	8	8	60	Glass, Elliot, & Co.	4 years
1858	Dardanelles ...	Scio and Candia	...	...	...	...	...	514	514	...	... ...	4 years
1858	England	Holland ...	4	13	0	10	00	140	560	30	Glass, Elliot, & Co.	4 years
1858	Ditto	Hanover ...	2 strands	16	3	12	6½	280	560	30	Ditto.	4 years
1858	Norway, across	Fiords	1 do.	14	1	10	6	16	16	300	Ditto.	4 years
1858	South Australia...	King's Island...	1	16	1	10	8	140	140	45	W. T. Henley.	4 years
1858	Weymouth ...	Alderney ...	...	...	...	...	...	93	93	...	... ...	4 years
1858	Ceylon	India	1	14	⅜	12	8	30	30	45	W. T. Henley.	4 years
1858	Ireland	Newfoundland	...	...	...	...	...	2,222	2,222	...	Glass & Elliot, & Newall & Co.	... ...
1859	Singapore ...	Batavia ...	...	...	...	...	...	550	550	...	Newall and Co.	3 years
1859	Athens	Syra	...	...	...	...	...	117	117	...	... ...	3 years
1859	Alexandria ...	... ...	4	16	3	10	1	2	8	...	Glass, Elliot, & Co.	3 years
1859	England	Denmark ...	3 strands	16	3	12	5½	368	1,104	80	Ditto.	3 years
1859	Sweden	Gotland ...	1 do.	14	1	12	9	64	64	80	Ditto.	3 years
1859	Folkestone ...	Boulogne ...	6 do.	14	3	12	0	24	144	32	Ditto.	3 years
1859	Across rivers ...	in India ...	1	13	0	9	2	10	10	...	Ditto.	3 years
1859	Malta	Sicily	1 strand	14	1	10	5½	60	60	79	Ditto.	3 years
1859	England	Isle of Man ...	1	16	2	10	6½	86	86	30	Ditto.	3 years
1859	Jersey	Pirou in France	1 strand	14	⅜	12	5½	21	21	15	Ditto.	2½ years
1859	Tasmania ...	Bass Straits ...	1	16	1	10	8	240	240	...	W. T. Henley.	2½ years
1859	Liverpool ...	Holyhead ...	2	16	3	12	6	25	50	...	Glass and Elliot.	2½ years
1859 1860	Suez	Kurrachee ...	1	...	...	...	...	3,499	3,499	...	R. S. Newall & Co.	... ...
1860	France	Algiers ...	1 strand	14	0	10	14 †	520	520	1,585	Glass, Elliot, & Co.	2 years
1860	Corfu	Otranto ...	1 do.	14	0	10	5½	90	90	1,000	Ditto.	2 years
1860	Denmark ...	Great Belt 14 miles	6 3	16	1 1	12 10	1	28	126	18	W. T. Henley.	2 years
1860	Dacca	Pegu	1	13	0	18	14	116	116	...	Ditto.	2 years
1860	Barcelona ...	Mahon ...	1	14	1	16	12½	180	180	1,400	Ditto.	2 years
1860	Minorca	Majorca ...	2	16	3	18	12	85	70	250	Ditto.	2 years
1860	Iviza	Majorca ...	2 strands	16	3	18	11½	74	148	500	Ditto.	2 years
1860	St. Antonio ...	Iviza	2 do.	16	3	18	11½	76	152	450	Ditto.	2 years
1861	Norway, across	Fiords	1 strand	14	1	10	6	16	16	300	Glass, Elliot, & Co.	1½ year
1861	Toulon	Corsica ...	1 do.	14	0	10	14 †	195	195	1,550	Ditto.	1½ year
1861	Malta	Alexandria ...	1 do.	8	½	18	11	1,535	1,535	420	Ditto.	1 year
1861	Newhaven ...	Dieppe ...	6	...	...	...	...	62	872	...	... ...	1 year
1862	Abermawr, Pembroke ...	Grenore, Wexford ...	4 strands	14	1	12	3	63	252	58	Glass, Elliot, & Co.	6 months
1862	England	Holland ...	4 do.	13	0	10	00	130	520	30	Ditto.	2 months
1863	Cape Carbalnara	Trapani ...	1	...	12	10	...	200	200	200	Ditto.	... ...
1863	Persian Gulf ...	... ...	...	...	...	...	...	20	20	...	Hall and Wells.	... ...
	In Germany, Russia, &c.		...	...	...	...	...	1,000	1,000	...	Feldon and Guilleaume.	... ...
						TOTAL		15176½	19549			

* Fourteen separate cables of 120 miles each.

† Steel covered with hemp.

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graphic means, from the British Islands, and across the Atlantic Ocean to Nova Scotia and the Canadas, the colonies, and continental kingdoms."

At that early period the public had scarcely realised the mighty progress of steam and railway engineering science, and only looked upon the electric telegraph as a necessary appendage to the railway, and but dimly comprehended its method of action, or the vital necessity which it has since become to the capitalist, merchant, and *agent de change*.

Mr. Brett, however, worked on, but receiving no support or encouragement from the British Government, to whom he had applied for assistance, he turned his attention to France, and, in 1847, received from the government of Louis Philippe an exclusive grant to lay cables on the French coast for ten years, which was afterwards renewed by the Emperor of the French, and in August, 1850, together with other gentlemen associated with him, he laid the first experimental line across the Channel from Dover to Calais.

This cable was simply a gutta percha covered copper wire, and, considering the manner it was laid, it is a wonder that it was at all successful. It was simply wound round a large drum, like a reel of cotton, placed upon the deck, and, as it ran out, large, heavy lead weights were attached at various lengths to sink it, which contained in themselves the elements of destruction. But the fates were propitious, and everything went well, the cable was laid, landed, and spoke—words that must have thrilled through the hearts of the anxious projectors, proving that the idea was no mere idle vision of the brain, as some eminent engineers had stated it to be, but a reality. Greatly to the regret and disappointment of all interested, the cable broke during the night. However, success had been such that the promoters set to work, and a more durable cable, from the specification of Mr. J. W. Brett, was begun by Messrs. Wilkins and Wheatherly, and finished by Messrs. Newall and Co., but the length proving insufficient when laid, it was buoyed, and the additional length manufactured by Messrs. Kuper and Co., now the firm of Messrs. Glass, Elliott, and Co., so that three different manufacturers assisted in making the first permanent cable.

It was laid in August, 1851; and although it has several times been broken by ships' anchors, yet at the present time it works as well, and is in as good preservation, as on the day it was laid, and is an example of the durability of submarine lines, even with rough handling, when the materials are good, well constructed, and properly laid.

The success of this undertaking having proved everything that the promoters anticipated, other enterprises immediately followed. The table, on the next page, gives full particulars of the various submarine cables.

It appears that 15,156½ miles of telegraphic cables have been laid. Some have proved most successful, while others have become total failures, and, at the present moment, there are only about 6,350½ miles at work. It will be seen that the average of lost cables is about one-third, if the Atlantic and Red Sea cables, which together make 5,761 miles, be taken away, on the principle that from the first they were totally unfitted for the work, and ought not to have been laid; the former from causes which I will hereafter explain, and the second from the fact that if the most ordinary precautions, and the experience obtained by the Atlantic cable had been observed, the line might now have been in operation.

It is also worthy of note that out of the 6,350½ miles, in perfect working order, upwards of 4,000 were manufactured by Messrs. Glass, Elliott, and Co.

It would occupy too much of your time this evening to discuss, separately, the causes which have occasioned the ruin of so many cables. I will, therefore, confine myself to the principal subject of the evening—the

Atlantic Telegraph.

It appears that, from the year 1845, Mr. Brett continually solicited aid from the British Government towards an Atlantic line, but without success until 1856, when the Government of Lord Palmerston granted a subsidy of £14,000, and the American Government gave a similar guarantee; each grant being still in force so long as a cable be laid down, and continue in working order between Ireland and Newfoundland.

Previous to this date, in 1851, Mr. F. N. Gisborne, an engineer, proposed the plan, which is now adopted, to shorten the communication between Europe and America, by making St. John's, Newfoundland, a port of call for Atlantic steamers, and constructing a telegraph from thence to join the American lines. His company, however, failed to carry out the undertaking, and was bought up by Mr. Brett, Mr. Cyrus W. Field, and other American gentlemen, who completed the communication to the American continent, and having obtained certain privileges from the legislature of that colony, and also the exclusive right to land cables, immediately turned their attention to the realization of a telegraph line across the Atlantic.

About this time, 1854, Professor Faraday, and Mr. Latimer Clark, made some experiments relative to an electrical phenomenon which had presented itself to the observation of persons working underground lines and submarine cables, viz., the difference in speed at which the fluid travelled along a wire covered with an insulating substance, and laid in the sea or earth, and along a simple wire suspended by insulators attached to poles. This had been observed by Mr. Varley in 1848, and by Mr. Siemens in 1849.

It was observed, in the case of the former, that a resistance was offered to the flight of the fluid from induction. That is, when a wire is covered with an insulating substance, say gutta percha or india rubber, and surrounded by water, or laid in the earth, and a current of electricity is sent along the wire, the travelling electricity excites in its progress an electrical force of an opposite kind, which attracts and retards the current moving freely on its journey, as it would do along an aërial line. It will be readily understood that the longer the cable the greater the resistance of the induction, and so greatly was this effect feared at that time, that it was said a cable of 2,500 miles could not be worked commercially.

The subject, therefore, had to be examined, and experiments made, to determine the law which governed the loss of speed, and the current's power to produce mechanical effects at the end of a lengthened journey.

Mr. Whitehouse, the late electrician of the Atlantic Company, at the request, and under an agreement with Mr. Brett, turned his attention to the subject, and made some valuable experiments upon a cable then being manufactured for the latter gentleman at Greenwich. The British and Irish Magnetic Company, who possessed long lengths of underground lines, placed them at this gentleman's disposal, and experiments, at which, I believe, Sir Charles Bright assisted, were made, extending over some 2,000 miles of insulated underground line.

The results then arrived at were sufficient to demonstrate, beyond a doubt, and have since been indisputably confirmed, that an Atlantic cable could be worked successfully and commercially, although not at the same high rate of speed as that effected on aërial lines.

These four gentlemen then associated together to carry out the undertaking. Mr. Brett, as the originator; Mr. Cyrus W. Field, on the part of the American interests; and Messrs. Bright and Whitehouse, as possessing the scientific element.

The Atlantic Company was then formed, and the necessary capital raised in £1,000 shares. But so eager and anxious were all parties interested to carry out this great work, that not sufficient time or attention was given for proper experiments to be made as to the adaptability of the cable to its future resting-place, and the work which it had to perform when there.

True it is that a few experiments were made at the works of Messrs. Brown, Lenox, and Co., upon several cables manufactured by Messrs. Glass, Elliott and Co., as to their breaking strain, and two were selected from the number tried. One was ultimately adopted weighing 93 lbs. to the mile, with a breaking strain of 3 tons. The other, although possessing greater advantages in strength, being made of single steel wires wound spirally for the outside covering, was not accepted, because of the difficulty and delay there would have been in procuring that description of steel wire. Had this latter cable been adopted, it might have shared the fate of the other, for the breaking strain of the other was sufficient to ensure its being laid safely: but that was not where the defects arose; and had the very best form of cable been subjected to the unfair treatment of the Atlantic, it must have shared a like untimely fate.

The rapidity with which the cable was manufactured would be a marvel of human industry, were it not for the fact that that most careful and watchful supervision required in making the joints and other detailed operations could not be carried out so perfectly as it might otherwise have been, a misfortune which dimmed the lustre of the achievement.

The core was covered with three coatings of gutta percha representing 7,500 miles of work. 335,000 miles of iron and copper wire were drawn out and spun into more than 47,500 miles of strand, and upwards of 300,000 miles of tarred hemp were saturated and spun round the core, and the whole was put together and woven into a cable in about the space of four months.

As the cable was made it was coiled into several tanks, and by an oversight quite inexcusable, it was left exposed to the weather at Greenwich, and so seriously had the sun effected it at one time, tha

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sixteen miles had to be cut out. The heat having softened the gutta percha, the inside copper wire was found protruding and touching the outside iron, thereby destroying the insulation. Now, it is reasonable to suppose that if 16 miles were seriously damaged, a greater length was also injured in a less degree by the same cause, from the copper conducting wire being forced from the centre of the gutta percha to within a small space of the outside, an imperfection which was not then discovered, but which may afterwards have contributed to accelerate the destruction of the cable.

The first attempt to lay the cable, in 1857, was unsuccessful, owing to breaking in the paying-out machinery, which was found unfitted for the operation. It was then unshipped and coiled into tanks made for the purpose at Plymouth, to wait for another year. During the interval it was completely overhauled, and a great many defective places and joints cut out, and upwards of one hundred fresh splices made. Although this was bad enough, yet I believe another operation were performed upon it, that no doubt told a tale when the cable was submerged, which was pricking it every two or three miles for faults, that is, pushing a needle at short lengths through the gutta percha to the copper wire to test it. Now, if this was done frequently, and the small aperture not carefully stopped up, which may not have been the case in every instance, the great pressure of the water would soon find out these small defects. Another great disadvantage connected with this cable was that owing to its being manufactured by two rival firms 200 miles apart, it was neither tested in one length during its manufacture, nor under water previous to being laid.

The next year the cable was a fourth time recoiled on board the *Niagara* and *Agememnon*, together with an additional length, making up the total to 3,000 miles. The ships met in mid-ocean, and the cable being spliced, one started for the American coast, and the other for the English, and, after three ineffectual attempts in that year, it was at last finally laid 5th August, 1858—laid, as everyone practically connected with the enterprise then knew, only as an experiment, for the injuries it had received were now patent to all; but the cable was made, and must be laid.

A very singular incident happened during the final laying. A series of preconcerted signals through the cable was kept up between the ships during the paying out, but a sudden cessation of these signals was on one occasion perceived, although the insulation was good, and after a time the currents came again as strong as before. This could only be accounted for on the supposition that the internal copper wire had broken from the strain, and that when the cable in which it was had reached the bottom, the two ends had been brought together again by the elasticity of the sheath. A serious fault of insulation also appeared in the cable at about 420 miles from the Irish coast.

From the 5th to the 10th August no messages were sent through the cable, owing to the necessary arrangements not being completed; from the 10th to the 17th no message beyond a few words could be either sent or received, owing to the weakness of the currents from leakage. On the 18th the signals got a little better, and constant communication was kept up, with more or less success, till the 2nd September, when it finally ceased to speak, after having transmitted

Messages.		Words.		Letters.	
97	containing	1,102	containing	6,476	from Valentia to Newfoundland.
269	„	2,840	„	13,743	from Newfoundland to Valentia.
366		3,942		20,219	Total.

The receiving instruments prepared to work the cable were upon the principle of that of Professor Morse, which is now universally adopted wherever there is a telegraph. Its construction is most simple. The electricity transmitted acts upon an electro-magnet, which is drawn down, whilst a long armature connected to it rises against a piece of travelling paper, making it touch an ink roller above, every time a current of electricity arrives, so that a series of long or short dashes is recorded, according as the current of electricity is kept on for a short or long period. The combination of dots and long strokes thus forms the alphabet.

CODE OF SIGNALS FOR THE MORSE INSTRUMENT.

A	— ———	Æ	— ——— — ———
B	——— — — —		
C	——— — ——— —	Ch	——— ——— ——— ———
D	——— — — —		
E	—	é	— — ——— — —
F	— — ——— —		
G	——— ——— —	Œ	——— ——— ——— —
H	— — — —		
I	— —	UE	— — ——— ———
J	— ——— ——— ———		
K	——— — ———		
L	— ——— — —		
M	——— ———		
N	——— —		
O	——— ——— ———	1	— ——— ——— ——— ———
P	— ——— ——— —	2	— — ——— ——— ———
Q	——— ——— — ———	3	— — — ——— ———
R	— ——— —	4	— — — — ———
S	— — —	5	— — — — —
T	———	6	——— — — — —
U	— — ———	7	——— ——— — — —
V	— — — ———	8	——— ——— ——— — —
W	— ——— ———	9	——— ——— ——— ——— —
X	——— — — ———	10	——— ——— ——— ——— ———
Y	——— — ——— ———		
Z	——— ——— — —		

Now, in the case of the Atlantic cable, the amount of electricity which arrived was much too weak to move this armature, and had it not been for Professor Thomson's marine galvanometer, in all probability no message whatever would have been deciphered. This instrument is as ingenious as it is simple, and I will first explain the construction of it, and then the manner of reading off the messages from it.

Round a small brass tube is wound a quantity of the finest copper wire, and suspended in this tube by a silken thread is a little mirror, about the size of a sixpence, with a magnet at the back; upon this mirror a light is thrown from a lamp, which is reflected back by the mirror upon a scale, showing a little spot of light. The apparatus is so simple and sensitive that the slightest current of electricity is sufficient to act upon the magnet attached to the mirror, and cause it to to move either to the right or left, according to the nature of the fluid, whether negative or positive. Of course it is necessary to use this instrument in a dark room. In the case of the Atlantic cable, when this instrument was used, a Morse instrument was fitted up on short circuit, that is, only working in the room, totally unconnected with the cable, and whenever the clerk saw the spot of light move on the scale, he immediately pressed down the Morse key, and so made a mark; but when the light vanished he took his hand off until it appeared again, so that he obtained by this means a series of dashes and blanks, according to the Morse alphabet, and that was the ingenious way that the messages were received and decyphered through the Atlantic cable.

On the 1st December, 1859, a Government Committee was appointed by the Board of Trade, at a cost of some £20,000, to inquire into the cause of failure. This committee, consisting of Captain Galton, Professor Wheatstone, Mr. W. Fairbairn, Mr. G. P. Bidder, and, on the part of the Atlantic Company, Messrs. E. Clark, Varley, Latimer Clark, and Saward, thoroughly sifted the whole subject, every person who could give any information being examined, and the result of their labours is to be found in a Blue Book of more than ordinary dimensions. They state that "the failure of the enterprise was to be attributed to the original design of the cable having been faulty, owing to the absence of experimental data; to the manufacture having been conducted without proper supervision, and to the cable not having been handled after manufacture with sufficient care. We desire, however, to observe that we are clearly of opinion that the failures of the existing submarine lines have been due to causes which might have been guarded against had adequate preliminary investigation been made into the question, and we are convinced that if regard be had to the principles we have enunciated, in devising, manufacturing, laying, and maintaining submarine cables, this class of enterprise may prove as successful as it has hitherto been disastrous."

Attempts to recover any lengths of the Atlantic cable failed owing to the lapse of time before they were made. However, one or two interesting facts came to light; one, that off Newfoundland the cable had been lying upon rocks, and had been chafed very much. Another, and a very important discovery was also made, namely, that wherever the outside covering had been protected by a serving of yarn, the wires were perfectly preserved and quite bright, whilst on a continuation of the same piece a few inches further and uncovered, the wire had corroded down to the thickness of a needle. It was also observed that the cable had been lying on a bed of copper ore, as a coating of that metal had attached itself to the cable.

With regard to the first of these discoveries, a fresh survey of the coast has been made by the United States Government, under the direction of Captain Orlebor, and a more suitable locality has been decided upon for the next cable, that pointed out by Captain Kell, in 1859, in Trinity Bay, New Pelican Harbour, the bottom of which consists solely of soft mud.

As to the second, it is now acknowledged by all connected with the

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science, that the outside wires should be protected from corrosion by hemp, and other substances. Messrs. Glass, Elliot and Co., propose a covering like the specimen on the table.

Since the Atlantic cable was made, the Gutta Percha Company have greatly improved the manufacture of this important article, and Mr. Varley gives it as his opinion that the insulation of the wires as now manufactured is ten times better than that made in 1857.

Great care is also now bestowed on testing and selecting the copper wire, as it is found that the quality of the copper exercises an important influence on the conducting power of the wire, in some instances a difference of from 30 to 50 per cent.

Another great improvement has been adopted by testing the gutta-percha covered wire under pressure according to the depth of water where it will have to be submerged. For instance, if a cable is to descend one mile into the sea, the pressure will be about 2,500 lbs. to the square inch. If two miles, 5,000 lbs., and so on, up to 10,000 lbs. to the square inch. The importance of this fact cannot be too strongly enforced, as any defect arising from air bubbles, or the smallest aperture like a pin's point, would be immediately detected.

The invention is that of Mr. Reid, consisting of a large cast iron cylinder, with a moveable cover to allow the coils of wire to be placed therein. The cover is bolted down and made perfectly air tight. The cylinder is exhausted of air, a vacuum being formed by means of an air pump; the stop cock to the air pump is then shut, and water is pumped in up to the force required—20,000 lbs. to the square inch, if necessary. One end of the wire is conducted from the interior through a stuffing-box to the outside, and attached to the testing instrument; the other end of the wire is insulated, the object being to keep the wire charged full of electricity, so that it may try to force itself out while the pressure is applied, and if the wire is not perfectly insulated and the slightest particle of electricity escapes, it is immediately detected.

The practical working of submarine cables has also undergone a change: instead of a large quantity of electricity being transmitted at one time to overcome the resistance of the wire, the wave now communicated is as small and as weak as possible, so as not to wear out the cable unnecessarily. The practice of the science has also demonstrated that positive currents of electricity, or those generated from the copper pole of the battery, are better adapted to the working of submarine cables than the use of the negative currents, or those from the zinc pole of the battery, or both alternately, which, it has been observed, will soon find out the weak and defective places, and destroy the cables at those particular parts. It was this that, in a measure, accelerated the fatal pause in the Atlantic cable, as every current sent along it literally only made matters worse by increasing the injuries which the cable had received previous to its submersion.

A great improvement has also been made in the construction of very delicate instruments for use on long submarine lines, and I am informed by Mr. Varley, that he confidently anticipates working through the next Atlantic cable at the rate of twelve to sixteen words per minute.

I will now draw your attention to the five proposed telegraphic routes to America. That from Ireland to Newfoundland (a distance of about 1,950 miles) having been found practicable, I will take it first.

In 1857, soundings were made by H.M.S. *Cyclops* under Lieutenant Commander Dayman, and by the U.S.S. *Arctic*, commanded by Lieutenant Berryman, which tended to show that there is a sudden descent about 180 miles off the coast of Ireland, of from 550 fathoms deep to 1,750 fathoms, and at this point it was considered by many that the cable received an injury from its being laid too taut. Orders were given on board, that when approaching this spot a good deal of slack was to be paid out, so that the cable might lay flat, and not be strained or suspended upon any ridge. This direction, however, was not sufficiently attended to, as the spot was passed during the night, and was not observed until the diminished strain upon the cable indicated shallow water.

Further soundings in H.M.S. *Porcupine*, in June, July, and August, last year, by Captain Hoskins, were made, with a view to find a more gradual slope into the bed of the ocean, and it is most satisfactory to report that by going more to the west, between Bantry and Blacksod Bay, a descent into the ocean is formed, varying from six to nineteen feet dip in 100 feet horizontal.

Soundings having also been made by the American Government off the coast of Newfoundland, by Captain Orlebor, and a channel is found to exist from the approach to Trinity Bay to a place called New Pelican, where there exists every facility for landing, &c., and by adopting this terminus upwards of fifty miles of cable will be saved.

The results of these soundings, and the great progress generally effected in all branches of the science of telegraphy, as well as the consideration of an offer made to the company by the eminent cable manufacturers, Messrs. Glass, Elliott and Co., that if they were selected to manufacture and lay the cable, they will undertake to keep it in working order for one year, and not only take shares for the amount of their profit, but also pay cash to the extent of £25,000 for shares, have induced the directors again to come forward and solicit public support for a new cable, which appeal, I am happy to state, is being responded to in a most liberal and encouraging manner.

The Company have most wisely appointed a Scientific Consulting Committee, consisting of Mr. Fairbairn, Mr. Joseph Whitworth, Professor Wheatstone, and Professor Thomson, in whose hands the selection of a suitable cable, and other matters of scientific interest apper taining thereto, may very properly be left.

It has been remarked that, although the Atlantic Company have appointed a committee of great engineering and scientific ability to assist in determining the selection of a cable, yet a similar committee of nautical gentlemen might also have been invited to assist at their councils. This, I apprehend, will be the case when the time arrives for active measures to be taken, the fact being, I have no doubt, that the Atlantic Company felt a difficulty in selecting a few out of the very large number of eminent and distinguished officers in H.M. navy.

The next route is the northern one, *viâ* Scotland, Faroe Islands, Iceland and Greenland (a distance of about 1,700 miles.) It appears that, in 1854, Colonel Shaffner traced out a route and obtained a concession from the King of Denmark for permission to land a cable upon his territories. Nothing was, however, done beyond this till 1859, when Colonel Shaffner, having chartered the barque *Wyman*, made a personal survey of the route. His survey was such that Her Majesty's Government was memorialised to have soundings made, and in June, 1860, Her Majesty's ship *Bulldog*, commanded by Sir Leopold McClintock, started to survey the deep seas for the proposed telegraph. He reported that from Scotland to the Faroe Islands the depths did not exceed 254 fathoms; from thence to Iceland the maximum depth was 683 fathoms; from Iceland to Greenland it was 1,200 fathoms; Greenland to Labrador 2,000 fathoms, whilst the bottom throughout appeared to be of fine sand and soft mud.

As Sir Leopold McClintock's instructions had reference only to the deep-sea soundings, a second expedition was fitted out, and this time at the cost of the promoters, to survey the different coasts, and to obtain all other necessary information. This expedition started in the celebrated steam yacht *Fox*, under the command of Captain Young. Still, however, it appears neither of the expeditions entered upon any very detailed survey, owing to the weather, and another must undoubtedly be carried out before a cable could be laid.

The promoters of this route have advanced many arguments, upon the ground of short lengths of cable, in its favour, and against the adoption of the old route from Ireland from the causes of induction, but they say nothing themselves about overcoming the difficulty which the magnetic currents of the earth will occasion to the working of their cables. Yet this, in the opinion of those well versed in the science, is likely to prove in the land of the *aurora borealis* a very formidable obstacle, independently of the danger from icebergs and the difficulty of repairing at all seasons any accident to the cable. Still, notwithstanding these difficulties, with the wonderful inventions which are every day being perfected, I believe that at some future and no distant time a cable may be laid by this route.

I now come to the Spanish or South Atlantic route (a distance of upwards of 2,000 miles), to which that Government has promised a large subsidy upon the capital required, so soon as the cable is laid. It starts from Cape St. Vincent to Madeira, thence to the Canary Islands, Cape de Verd Islands, then across the Atlantic to the Island of St. Paul's, to Cape St. Roque. This is another route advocated upon the ground of short length, the longest section being about 900 miles. This line has not been specially surveyed for the purpose, but from the soundings laid down in Lieutenant Maury's chart, it appears that the only deep water to be found along the whole route is that near the Island of St. Paul's, which gives a depth of three miles. Still, if a survey was made, it is not unreasonable to anticipate that by going either to the north or south a less deep decent might be found; but another obstacle presents itself, and that is, the heat of the Gulf Stream, which will pass over the cable, and may affect the gutta percha. This, however, is only a supposition, and I hope it will not prove correct, and that no insuperable barrier may exist to the successful working of this line also.

I now come to another route, which proposes to start from the coast of France, probably Brest, to the Azores, thence to the Island of Bermuda, to Cape St. Hatteras, which would make a distance of 3,000 miles. This route has not been especially surveyed for this object,

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and the scheme is thought by some to be perfectly impracticable; first, owing to the great distance and depth (soundings to 7,000 fathoms having been made with "no bottom"); secondly, from the fact that the Azores are volcanic, so that it would be dangerous to lay a cable in their immediate neighbourhood, as a few years since an island disappeared altogether.

This project, however, as I was recently informed, on credible authority, has been abandoned in favour of a direct line from France to the Island of St. Pierre, which belongs to France, and lies off the coast of Newfoundland. I am also given to understand that the Emperor of the French has so far patronised this latter plan, as to promise a considerable subsidy annually upon the capital required for its accomplishment. Already, indeed, active measures have been adopted to form a company and to commence operations forthwith. It is calculated that this direct line would not exceed 2,000 miles in length.

With regard to the practicability of this project, as, indeed, of any other, I would quote some remarks of Lieut. Maury, in his work on the physical geography of the sea, which apply universally. He says:—

"I have no doubt whatever as to the ultimate success of a telegraph across the Atlantic. Indeed, the only limit to our power to establish, at pleasure, lines of submarine telegraph, is the limit, if any, which nature herself may have interposed upon the galvanic currents.

"The sea offers no obstruction, on account of its depths, or its currents, to lines of any length. A line with an unbroken conducting wire across the Atlantic or Pacific is as practicable as one across the Alps or Andes.

"The real question for future projectors of lines of submarine telegraphs is not how deep, or how boisterous, or how wide the sea is, but what are the electrical limits to the length of submarine lines."

I will also call your attention to a remark by the same great authority relative to the pressure of the ocean upon a cable. He says, at page 343, "The pressure on the telegraph plateau between Newfoundland and Ireland varies from 200 to 300 atmospheres, that is, from 430,000 to 650,000 pounds to the square foot. Chemical forces may be measured, and consequently overcome by pressure, for the gases generated by chemical decomposition are themselves capable of exerting in the process of that decomposition only so much pressure, but if we subject them to a greater pressure they cannot separate, and decomposition cannot take place."

In proof of this I refer to a recent discovery of Ehrenberg. In the specimens obtained at a great depth from the Mediterranean, that celebrated microscopist has distinctly recognised fresh water shells with flesh in them, from which interesting fact we may infer that the very volatile gases which enter into composition for the formation of the fleshy parts of marine animalculæ are subjected to such a pressure upon the bed of the ocean that they cannot separate. If this inference be correct, and it doubtless is, may we not proceed a step further, and conclude with reason, that with the pressure of the deep sea upon it, the gutta percha used for insulating submarine wires becomes "impervious to decay." This remark has been fully borne out by experience, as it is found that gutta percha, under pressure, greatly improves in condition, and has never been known to show the slightest symptoms of decay under water.

I now come to the consideration of the fifth and last route to America, which may be termed the overland route, and of which upwards of 5,000 miles have already been completed through Russia and Siberia, *viâ* Ormsk, the Ural Mountains, to Irkutsk, whilst next year the line will be completed to Nikolaevske and the Amoor, giving a telegraphic communication from Japan to Europe.

From Nikolaevske a submarine cable would be laid to Kamtschatka, then from Petropaulovsk to the several Aleutic Islands, 12 in number, thence extended a distance of about 1,900 miles to the Peninsula of Aliaska, from whence a land line would be continued to California, to which point the line is now open from New York.

On looking at the map, at first sight, a shorter submarine route would be found across the Behring Straits, a distance of only 50 miles, but the impracticability of carrying out such a line arises from the nature of the countries around Behring Straits and the North-Western part of America, through which the aërial lines would have to be constructed. They are so wild, and so covered with perpetual snow and ice, that even the maintenance as well as the construction would be impossible, quite independent of the magnetic influence which affects the line. It is, therefore, proposed to carry the line *viâ* Kamtschatka and the Aleutic Islands, but when this will be accomplished it is impossible to say; still the Russian Government is pushing on their works, and, next year, they may have reached Irkutsk.

I have now briefly reviewed the subject; but I have a few words to say about the proposed cables, and telegraphing to America or elsewhere without the aid of wires at all. Hundreds of patents have been taken out for different kinds of cables, but the original spiral form of twisted wires for the outer covering, first adopted by Mr. Brett, still keeps its ground. It is impossible to say what form of cable will be adopted for the new Atlantic line; but no doubt every experiment and trial will be carefully made, and no expense spared to arrive at a satisfactory result; and when a suitable cable has been decided upon, and a careful supervision given to its manufacture, there can be no doubt that it will be successfully laid. Amongst other new inventions is that of Mr. Duncan's Ratan Cable, which he advocates upon the grounds of its flexibility without elasticity, of its being imperishable in water, and of the cheapness at which it can be manufactured.

Another form of cable, containing some new combinations, has been adopted by the Indian Government for their cable of 800 miles down the Persian Gulf. The novelty which it possesses is in the manufacture of the copper wire, which is a single wire instead of a strand of several, so much advocated, as affording great additional strength, and avoiding the possibility of a total fracture at one particular spot. But a strand has this disadvantage—that if one wire breaks, the sharp points are liable to start out and pierce through the gutta percha. Want of solidity is also urged against a strand, as it is alleged that if water penetrate in any place to the wire it will pass along the wire as in a tube. To remedy this defect, the Gutta Percha Company propose to coat the central wire of the strand with Chatterton's compound, and bed the wire in it during the process of twisting.

Mr. Daft proposes to obtain the same object by bedding copper wires coated with brass in vulcanized india rubber.

Mr. Varley proposes using three or more insulated wires joined together at different distances. If any one wire (or two wires) be exposed by injury to the water, the current will eat it away, and thus increase the resistance of the escape without increasing sensibly the line,—the more the wire is eaten away the better the cable becomes. Such a cable may be defective in twenty places, and yet work perfectly.

Mr. Newall unites the several wires of a strand with solder.

Mr. Latimer Clark, who, with Sir Charles Bright, are appointed engineers of the Indian Government, proposes to obtain this solidity by making the conductor in the shape of a solid wire, divided into three or four sections, longitudinally fitted, and rolled into each other, and they have adopted this form in the Persian Gulf cable now being manufactured by Mr. W. T. Henley.

The outside covering of iron wire is the old form, but it also is now coated with hemp, and a tarry composition to protect the iron from rusting, a plan which will be universally adopted in future after the experience gained with the Atlantic and Red Sea lines.

But while various parties have been at work devising new cables, another gentleman, a Mr. Haworth, has been at work to discover a means of conveying electric signals without any wires at all. He has taken out a patent and filed drawings of the apparatus, but I have not met one single gentleman connected with the science of telegraphy who could understand his process of action, or its probability of success, although the theory is an old one. I applied to him for some information relative to his experiments, but he is unwilling to communicate any particulars until the success of his plans has sufficiently demonstrated their practicability.

With respect to the comparative merits of gutta percha and india rubber, I may remark that one of the earliest substances used for insulating purposes was india rubber, but, owing to the difficulty of efficiently covering the wire, and from the oxidation which took place when it was exposed to the atmosphere, it fell into disuse after the introduction of gutta percha, and although universally admitted to contain insulating properties far above any other substance, no attempts, I believe, were made for several years to perfect it for telegraphic purposes.

Messrs. Silver have, however, in the last few years, turned their attention to the subject, and have been rewarded by producing a substance called ebonite, which is being universally used for various insulating purposes.

They have also arrived at a perfection not hitherto obtained in covering wire. A mile length, prepared by the Messrs. Silver, was submitted to the Government Scientific Committee, and reported on by them as containing the highest insulation ever attained.

They state in the report, "That india rubber surpasses all other materials in the smallness of the amount of its inductive discharge, and the perfectness of its insulation." Although this testimony carries great weight, yet the substance itself has not hitherto proved very durable, nor has it been adopted to any great extent, but the

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manufacturers are sanguine enough to believe that with the present and other improvements which may be made, it will one day surpass everything else.

As regards gutta percha, no vegetable substance has yet been discovered which presents the same advantages to the electrician as this gum. Its many valuable properties are too well known to mention; suffice it to say that it has never been known to decay under water, and, as far as experience goes, it may in that case be said to be indestructible when suitably protected. The manufacture of the article has now arrived at a perfection to leave nothing to be desired, but that the supply may not fail.

At a recent repairing operation in the case of the Belgian cable (made by Mr. France, the Submarine Company's engineer), and which was broken by a ship's anchor, it was found that, although the large iron wires of the outer covering were broken, as well as the internal copper conductor, yet so tenacious was the gutta percha, that it resisted the enormous strain, allowing itself to be literally drawn out from the thickness of a piece of macaroni to an attenuated shred of vermicelli, thus adding another fact to those already established of its indestructibility under water, and its superiority over all other insulating materials for submarine cables.

The Submarine Telegraph Company liberally offered the use of their wires to connect the Society's rooms this evening with all the capitals of Europe, but upon applying to the engineer to make the necessary arrangements, it was found impracticable, without great difficulty and expense, owing to the wires of the Company being laid under the roadway in the Strand.

I regret this very much, as I had anticipated repeating an experiment which I witnessed some time since, namely, that of sending a telegram over the longest distance of land, and through the greatest extent of sea that was then possible. The experiment was so wonderful and interesting that it will bear relating, as showing what can be accomplished by the aid of electricity, although it does not refer immediately to the Atlantic cable.

A continuous wire was joined up from London to the island of Corfu, a distance of nearly 2,000 miles, but as the wire had necessarily to be suspended from hundreds of poles, extending over such a great distance, and where, perhaps, at every connection a small amount of electric fluid would escape, the charge would not last out to reach its destination without some additional assistance on the road. It, therefore, becomes necessary in such operations to refresh and invigorate the lightning, as in the old slow time a man would water his horses on the road, or as the Brighton "Age" would, in its then wonderful journeys, "change horses in half a minute."

To provide this assistance, instruments called "relays" were placed at different intervals along the line, the object of which was to receive the nearly exhausted current of electricity, revive it instantaneously with additional strength, and send it on to the next relay, and so on till it arrived at its destination.

In order to fully realise this wonderful achievement, we will trace the progress of a message along the route from London to Corfu.

The transmitting instrument in connection with the battery generating the electricity is set in motion. A flash of electricity is liberated, and wings its way along an insulated wire, under the busy streets of London, and under the low, quiet turnpike roads to Dover, then under the surging waves through the submarine cable, peacefully lying at the bottom of the Channel, to Calais, where it mounts up to land again, traverses the immediate country to Paris, picks up a relay of electricity charged from a local battery in waiting to revive its now languishing strength; and, reinvigorated, pursues its silent and instantaneous flight through cities and towns without stopping, but every now and then receiving assistance and new life, till it arrives at Turin; thence on to Genoa, from whence with increased power it dashes through the submarine cable, 100 miles in length, to Corsica, rushes over this island in the quickness of a thought, descends again into the sea, across the Straits of Bonifacio to Sardinia, up on land again, through villages, and over the Gallura Mountains, where the deadly malaria fever lurks, that killed so many men in its construction, to the eastermost point of this island; then again taking a header through another submarine cable lying at the bottom of the deepest part of the Mediterranean to Malta, over its rocky ridges to the other side, from whence it finally flashes through another submarine cable under the sea to its destination, Corfu, doing the whole distance of 2,000 miles in two seconds and a half, and passing over, in its transit, some of the highest mountains in Europe, as well as five times descending more than a mile's depth into the ocean.

But the coming back of this mysterious agent is still more wonderful than its guided transit along the wire; for there it has an operator, philosopher, guide, and friend to direct its course; but now it returns home again, not along a conductor supplied by a man's ingenuity but alone through the earth. "The world is all before it where to choose," for after it has reached its destination, and recorded its symbolic mission, it is transmitted down a wire, sunk in the earth for that purpose, to find its mysterious way back to the spot from whence it started, and passes up another wire similarly placed in the ground, again into the presence and power of the operator; for, until it has arrived home, the electric circuit is not completed, and no signal is given.

Wave after wave of electricity was transmitted, until the whole message of some twenty words had been communicated to the island of Corfu, the transit of the whole occupying three minutes; then a brief interval, and click, click, the serpentine length of paper unwinds itself, containing the reply, which came back in even less time than the message sent.

Having now briefly reviewed the subject of submarine telegraphs generally, and the Atlantic in particular, with some, I trust, pardonable digressions, I shall proceed to sum up my conclusions in as few words as possible.

1. First, then, with respect to the original cable, I cordially acquiesce in the resolutions arrived at by the committee appointed by the Board of Trade, that "the failure of the enterprise was to be attributed to the original design of the cable having been faulty, owing to the absence of experimental data; to the manufacture having been conducted without supervision; and to the cable not having been handled, after manufacture, with sufficient care."

2. That intercommunication between the Old and the New World, by means of an Atlantic telegraph, is not more desirable than feasible.

3. That the accidents which befel the first cable arose from causes which, there is every reason to believe, will not occur again.

4. That the improvements in the process of manufacture of the cable itself, as well as of the insulating medium, have greatly enhanced the value of both, and in the latter case to an extent of 10 to 1, as compared with the insulating medium of 1857.

5. That we are no longer exposed to the mercy of the elements in the matter of laying and paying out the cable, as on the previous occasion, the *Great Eastern* having obviated the serious danger and difficulties hitherto experienced from the pitching of vessels employed in these operations, and by which, through the strain upon the cable, success was rendered highly problematical.

6. That the above conclusions are borne out by the liberal proposals of those eminent and successful cable manufacturers, Messrs. Glass, Elliott and Co., to which I have before alluded.

7. That recent experiments fully demonstrate the possibility of working a one-wire cable commercially; but that it will be cheaper in the end for the Atlantic Company to lay a cable consisting of at least two if not three wires, because there will be such an influx of messages both ways, that if a one-wire cable only is laid, telegrams will have to wait two or three days before they can be sent. The chances of success would also be greatly enhanced by having more than one wire.

8. That of all the various routes contemplated, that between Ireland and Newfoundland presents advantages superior to any other.

9. That considering the issues at stake, the present state of the science of telegraphy, and the fact that it has already interfered to point out the causes of the former failure, and the remedies to be adopted in any subsequent undertaking, Government might reasonably be called upon for another grant, at all events, to perfect the experiments necessary in a second and successful attempt to lay down the Atlantic Telegraph.

10. That the time has fully come when that attempt should be prosecuted in the interests, not only of science, commerce and social economy, but also from a regard to the still higher interests of civilization and humanity.

In conclusion, I indulge a fervent hope that those who have sacrificed so much already, and who, nevertheless, are prepared to risk still more to carry out this great work, may in the end reap the full reward of all their noble enterprise. Should, however, that pecuniary reward be wanting, of this I am well assured, that the consciousness of being pioneers on the high road to peace and amity among the nations of the earth, and above all, between the different families of the great Anglo-Saxon race, will be to them a source of satisfaction, alike deep and permanent. I shall only add the expression of a wish, in which I am certain all here will join, that our kindred across the Atlantic, diverted from scenes of fratricidal strife and bloodshed, may ere long turn their thoughts back again to such subjects as I have been discussing this evening.

The discussion which took place upon this important paper is postponed until next week.

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THE TELEGRAPH TO INDIA COMPANY, LIMITED.

Statement of the Capital Account to 31st December, 1862.

Dr. *Cr.*

EXPENDITURE.	£	s.	d.
Amount expended to 30th June, 1862, as per last statement	41,314	13	2
Examination of old cable (eastern section)			
Charter of S.S. "Sir James Duke"	3,300	0	0
Fittings of steamer chains, ropes, and other stores	22	15	0
Wages of staff	797	8	5
Travelling expenses and Victualling	1,844	10	4
Establishment of stations	16	10	0
Hire of steamer	60	0	0
Advertisements	90	15	4
Furniture, fixtures, and fittings	33	0	6
Repairs of cable	338	16	0
Exchanges and commission	24	16	1
Insurance	497	4	10
Interest	90	15	5
Incidental expenses	24	18	8
	£48,456	3	9
Amount of outstanding Accounts	4,538	6	10
Total	£52,994	10	7

RECEIPTS.	£	s.	d.
Capital realised, viz.; Deposit of 20s. per share on 45,175 shares	45,175	0	0
Balance	7,819	10	7
Total	£52,994	10	7

Statement of the Revenue Account from 1st July to 31st December, 1862, in England, and from last Statement to 31st October, 1862, Abroad.

Dr. *Cr.*

EXPENDITURE.			
Compensation (returned message money)	138	4	8
Land line inspection and maintenance	243	5	5
Salaries at home and abroad, and allowance for quarters	2,129	18	2
Exchanges and commission	2	5	4
Office charges, postages, stamps, &c.	162	15	0
Repairs and maintenance of instruments and batteries	17	2	9
Printing, stationery, and books	142	19	4
Travelling expenses	67	2	10
Establishment of stations (victualling Jubal Station)	389	9	6
	3,293	3	0
Balance	494	15	10
	£3,787	18	10

RECEIPTS.	£	s.	d.
Balance of Revenue Account as per last statement	97	2	4
Amount of message money	3,686	1	6
" transfer fees	4	15	0
	£3,787	18	10

Balance Sheet of the Company made up to 31st December, 1862.

Dr. *Cr.*

CAPITAL:				EXPENDITURE:		
Amount received on account of 45,175 shares	45,175	0	0	Amount chargeable against capital as per accompanying statement of the capital account	48,456	3 9
Less. Expended as per last statement	41,314	13	2	Less. Expenditure as per last statement	41,314	13 2
			3,860 6 10			7,141 10 7
LIABILITIES:				Amount of outstanding accounts		4,538 6 10
London and County Bank	6,000	0	0	Cash Balance:		
Bills payable (owners of "Sir James Duke")	3,039	5	0	Balance at the bankers'	803	11 10
Peninsular and Oriental Company	1,098	3	11	In the hands of the General Superintendent, the Engineers, and other officers of the Company	2,623	18 1
Sundry accounts and deposits on message account	614	15	9			3,427 9 11
			10,752 4 8			
NET REVENUE:						
Balance as per last statement	97	2	4			
Receipts from 1st July to 31st October	3,686	1	6			
Transfer fees	4	15	0			
	3,787	18	10			
Less. Expenses chargeable thereon	3,293	3	0			
			494 15 10			
			15,107 7 4			15,107 7 4

The following are additional Assets of the Company.

New cable on board the S.S. "Sir James Duke."
Old cable picked up on board the S.S. "Sir James Duke."
Submarine instruments and batteries complete for eight stations.
Land line in Egypt (220 miles).
Freehold house at Aden.
Furniture for eight stations.
Land line at Kurrachee.
Cash balance to be received from the Red Sea and India Telegraph Company.

Examined and found correct, { RD. MILLS. / A. S. WILDY.

MACDONALD STEPHENSON, CHAIRMAN.
W. MAYO, SECRETARY.

TELEGRAPH TO INDIA.

THE second ordinary meeting of this company was held on Monday at the London Tavern, Sir M. Stephenson in the chair.

The report, which appeared in the ELECTRICIAN, was taken as read.

The CHAIRMAN said the two prominent features in the report, to which the directors invited special attention, were the leases of the Alexandria and Suez line to Messrs. Glass, Elliot, and Co., and the proposed construction of a new line to connect the company's telegraph with Constantinople and the Persian Gulf line to India. By the former the shareholders would receive from 4 to 5 per cent. per annum from the 1st of January last for the next four years, the line being maintained in good condition without any charge to the company. At the expiration of that period the increased local traffic was expected to augment the receipts considerably, when the company would be enabled to renew working arrangements with the lessees, or to retain the line in their own hands, as might be found most advantageous to both parties. The second subject for consideration by the shareholders was one which affected their interests from the intrinsic and permanent value which would be imparted to their Alexandria and Suez line. The addition to the present through and local traffic of all the telegraphic communication between Constantinople, Syria, and Egypt, and a portion (and in case of direct accident to the line, the whole) of the India and China messages must necessarily augment the returns of the company's line in Egypt to a very considerable extent, while any interruption to the Malta line would divert the whole of the existing Egyptian traffic to the proposed new line. He then read the terms of the proposal of Messrs. Glass, Elliot, and Co., which he thought was liberal, and satisfactory. The proposal was to the effect that Messrs. Glass, Elliot, and Co. would undertake to construct the line from Cairo, or any preferable part of the Alexandria Suez line to El Arish, and thence to Beyrout, the company to pay them for the same in advance, £20,000. The distance being assumed as 400 miles, and for each additional mile £50, and so in proportion for a less distance. The company were to provide the instruments for working the line so far as their present stock would admit. If the company desired to extend the line to Diabecker to connect it with the Constantinople line, they would construct it for £50 per mile, paid in advance. They also agreed to work and maintain the line in good condition (wilful damage excepted) and to pay the company 7½ per cent. upon the capital expended (subject to a proportionate deduction while the line might be out of repair from wilful damage) until the line earned 15 per cent. net profits, when the guarantee should be increased to 10 per cent. The chairman said those conditions appeared to the Board to be unexceptionable. The company's power being insufficient, the simplest way of carrying out the arrangement was to register the new line as the Syrian Telegraph Company, under the Limited Liability Act, and to allow every shareholder in the Telegraph to India Company to claim his equal number of shares in the Syrian Company. The amount of capital would be £50,000, in shares of £1 each, to be at once paid up, and invested in Government securities until Messrs. Glass, Elliot, and Co. had approved the survey and specifications of the engineers, and were prepared to proceed with the work, when the guaranteed interest of 7½ per cent. would commence. The closing of the Jubal station when the line was in full working order was unavoidable, as an accident nearly occurred to one of the Peninsular and Oriental Company's steamers, which was aground for six hours when calling for despatches. The engineer's report on the 200 miles of new cable showed it to be in as good condition as when first made. Application had been made to the Government to allow the cable to be used on the Persian Gulf line, with which the Board hoped and anticipated compliance, as they considered the company had strong claims upon the consideration of the Government under all the circumstances. He concluded by moving the adoption of the report and accounts, and that the meeting highly approved the arrangement made with Messrs. Glass, Elliot & Co. for working the company's line from Alexandria to Suez.

Mr. DENT seconded the motion.

Mr. SEBAG said he considered the sum of £2,500 a-year for four

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years, agreed to be paid by Messrs. Elliot and Glass an adequate return on the company's capital, particularly as it was contingent on the working of the Malta and Alexandria line.

A long discussion ensued in which Mr. PRICE, Mr. ELLIOT, Mr. GLASS, Captain ANGUS, and other shareholders took part, on the subject of realizing the assets and winding up the affairs of the company.

Mr. DENT explained that the company was formed for the purpose of repairing and working the line from Alexandria to Kurrachee. 200 miles of new cable were sent out for the purpose, but the engineers on examination found the cable in such a state that it could not be repaired. If they could have succeeded in the enterprise, they would have realized 25 per cent. on their capital for 25 years. (Hear.) They had a good land line from Alexandria to Suez, and thence to Jubal. They had also 200 miles of new cable on hand, and other property to dispose of. They had an offer of £2,500 a-year, which would yield them for the next four years between 4 and 5 per cent. on their capital, which they could accept or reject as they pleased.

After some explanations from the CHAIRMAN, resolutions were agreed to, adopting the report, approving the arrangement with Messrs. Glass, Elliot, and Co., re-electing the retiring directors, Mr. Dent and Captain W. H. Hall; increasing the number of directors to nine; and electing Mr. C. L. Peel a director of the company. The meeting also approved the proposed arrangement for forming a company with a paid-up capital of £50,000 for the purpose of making a line of telegraph to connect the company's line with the Constantinople line and the Persian Gulf line to India in accordance with the proposals of Messrs. Glass, Elliot, and Co.

The proceedings concluded with a vote of thanks to the chairman and directors.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

CONDUCTIVITY AND RESISTANCE.

To the Editor of THE ELECTRICIAN.

SIR,—I am afraid it would be necessary to take up a very considerable portion of your space before many differences of electrical doctrine between Mr. Laming and myself could possibly be removed by discussion. While acknowledging the fact that I have profited in no small degree by the study of several of the theoretical expositions in the "Steps to Theory," written, as I understand, by Mr. Laming, and adopted editorially in your columns; I am surprised that some of the views put forward by the same writer should have been allowed to pass unchallenged by higher authority than that which could be attached to my own observations. In regard to the article under this heading in your last number, I must state that I know of no electrical "resistance" save that of the "want of conductivity," nor can I, and others who have read Mr. Laming's latter articles, find any foundation for supposing that the common acceptation of the former term can be a mistaken one. The analogy between the "conduction of electricity by a wire, and the passage of water through a pipe," I consider to be very limited and imperfect; and any theory or explanation based upon it must be unsound and dangerous.

Mr. Laming states that he limits the meaning of the term "resistance" to the inertia which is opposed to the motive tension. To this statement I may limit my present remarks. I think I may confidently assert, as a well-established fact, that no "opposing force" is offered to the motive tension other than the want of conductivity or what is *commonly termed* the "resistance" of the conductor. What Mr. Laming appears to regard as the "inertia" of the conductor, opposing the effect of charge is, I maintain, evidently due to the *diminution of the motive tension*. Does Mr. Laming overlook the fact that in charging a submarine wire the motive tension, in the batteries generally used for signalling, falls to zero. What other explanation besides this is required to account for the retardation of the signal? As the tension again rises, the current passes in proportionate degree. I should mention that this view by no means originates with your humble servant, it is ably expressed at p. 49 of the present volume of the ELECTRICIAN.

I am at a loss to perceive what advantage is to be gained, even according to your contributor's views, by constructing the coils of signalling instruments of wire of the same size as the line wire. The 20 units of length of No. 40 wire, which has been mentioned, is the coil of a signalling instrument worked through a resistance of 2,000 units of No. 16 wire. This coil might be constructed with 20 units of No. 16 wire, but it would be clumsy and inefficient, and the advantage, on the other hand, would be—nothing.—I am, sir, yours, &c., LONDON DISTRICT.

DURABILITY OF INDIA RUBBER.

To the Editor of THE ELECTRICIAN.

SIR,—In your last number a letter signed "Augustus F. A. Greaves," addressed to the *Melbourne Argus*, gives an account of the discovery amongst the *debris* of the *Dunbar*, shipwrecked some five years ago, a quantity of india rubber which remained in a perfect state of preservation despite its long immersion in sea water; the fact is one of considerable importance as bearing upon the future operations in submarine telegraphy. The statement made by Mr. Siemens before the Institution of Civil Engineers on the 20th May, 1862, viz., that "*its (india rubber) gradual dissolution in sea water was a circumstance which alone rendered it inadmissible for submarine wires, unless it was securely enclosed in another waterproof medium,*" meets with a timely and complete refutation. To those practically acquainted with the quality and composition of the material, the statement of Mr. Greaves caused neither wonder nor surprise, the durability of the material while immersed in water has been incontrovertibly established. Can its opponents produce a specimen deteriorated by protracted submersion in fresh or salt water?—Yours, &c., FAIR PLAY.

Jan. 3rd, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—In reply to the inquiries of your correspondent, "Amateur," respecting the formation of the primary coil, I have much pleasure in forwarding the following results of my experiments.

First, then, as regards the number of layers:—

Theory would naturally lead one to infer that, a coil consisting of a single layer of thick wire, excited with a quantity battery, should give a far more powerful effect than one composed of three or four layers of a smaller wire, even though the latter be connected to a battery possessing considerable intensity, for, with the former arrangement, we not only bring the iron core nearer to the secondary coil, but also diminish resistance to the battery current.

Notwithstanding, however, numerous experiments on this point, I have never as yet been able to obtain a satisfactory result with either one or two layers, however great the quantity of the battery, the diameter of the core, or the length of the coil. With my coil, three layers of No. 12 gives a very powerful spark, but I nevertheless prefer four layers of No. 14. It appears to me that the induced current in primary coil, does not acquire sufficient intensity to be freely absorbed by the condensers, until the wire, forming the coil, has attained a considerable length.

This, probably, however, might be met by employing a more extensive condenser; or, perhaps, where the tension of the battery was very low, by connecting to the primary wire, in place of the condenser, a secondary pile.

As a rule, it would appear that the greater the amount of battery power employed, and the longer the primary wire, the more perfect should be the insulating substance, separating the sheets of tin foil in the condenser, and *vice versâ*.—I remain, sir, yours very truly, W. H. MONNEY.

January 31st, 1863.

RAILWAY TELEGRAPHS.

To the Editor of THE ELECTRICIAN.

SIR,—In your No. 64, for January 23rd, you have the extract from Mr. Preece's paper, on the above subject, read at the Institution of Civil Engineers, on the 13th inst.

In this extract, after describing the different instruments used on various lines, it states: "It was shown that in all these systems the two signals, *danger* and *safety*, were not sufficiently opposite in their indications to be unmistakable, and that this was obviated in an instrument invented by Mr. Highton in 1854, and recently applied on the Great Western line by Mr. Spagnoletti.

The instrument here alluded to is one which I have lately introduced, and is now most successfully working on the Metropolitan and other lines.

There are no instruments of Mr. Highton's on the Great Western or any of its branches.

If you will do me the favour of inserting the above, you would much oblige—Yours obediently, C. E. SPAGNOLETTI.

Paddington Station, Feb. 2nd, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—I have a coil machine, in which the secondary is of rather large wire, in comparison with that generally used; and, being desirous of increasing its power, it has occurred to me that I could do so by winding a third coil, much longer, and of finer wire, upon the secondary, and connecting the terminals either to those of the secondary coil, or making use of a separate commutator for this tertiary coil. Will you kindly favour me with your opinion of such an arrangement, as I am desirous of knowing whether such a thing has previously been tried, and if so, what results have been attained. My impression is, that the induced current in the secondary would induce another current of higher tension in the longer and finer tertiary coil, but my leisure time being extremely limited, it would be very inconvenient to me to try the experiment, unless assured that it would give a satisfactory result.

Following the instructions given in No. 63, except in the introduction of a porous cell 1½ inch high, made of the same clay as ordinary biscuit ware cells in lieu of the Dutch pipe, I have made a single cell of the miniature Grove's battery, and find it x-cells everything I have hitherto used.

It was charged with 1 dram of sulphuric acid to 4 of water for the outer jar, and 40 minims of concentrated nitric acid for the porous cell.

This, attached to the rotating magnet, which I described in a previous number, worked it very satisfactorily for thirty-five minutes, and then at-

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tached for fifteen minutes to the coil, it gave very powerful shocks. Lastly, I connected it to a single coil, quantity galvanometer, and obtained the following results:—

At 12·55 p.m., the deflection was 65°					
„ 12·57 „	„	„ 60°,	interval of 2	minutes.	
„ 1· 5 „	„	„ 55°,	„ 8	„	
„ 1·15 „	„	„ 50°,	„ 10	„	
„ 1·30 „	„	„ 45°,	„ 15	„	
„ 1·35 „	„	„ 40°,	„ 5	„	
„ 1·41 „	„	„ 35°,	„ 6	„	
„ 2· 5 „	„	„ 30°,	„ 24	„	
„ 2·17 „	„	„ 25°,	„ 12	„	
„ 2·32 „	„	„ 20°,	„ 15	„	
„ 3·23 „	„	„ 15°,	„ 51	„	
„ 4·50 „	„	„ 10°,	„ 87	„	
„ 6·25 „	„	„ 5°,	„ 95	„	
„ 7·50 „	„	„ 0°,	„ 85	„	

The discrepancy in the periods occupied in falling through the same number of degrees, at different intervals, is a phenomenon I am unable to account for.

Considering that it has always hitherto taken three cells of the cast iron battery (previously described by me), to work the same rotating magnet for three hours, with a single charge, consisting of about twenty times the quantity of nitric and sulphuric acids, as a matter of expense, independent of the facility of construction and neatness of appearance, your students generally have much cause to thank you for this, your latest contribution, to their special edification.

It would be a great boon to me, and, no doubt, to many others of your students, if you could prevail upon Mr. H. Tunks to give a description of his electric clock, worked with a single pair of Smee's plates. All the descriptions I have yet met with for making this useful and ornamental desideratum, are so complex, and appear to require such nicety of manipulation, and expensive material, that they frighten one out of the hope of an amateur being able to make one, yet there must be some simple and effective method suitable for ordinary purposes, and such Mr. Tunks appears to have discovered, and will, no doubt, for the benefit of his younger brethren in the science, communicate the *modus operandi*, if requested to do so.—I am, sir, yours respectfully,

K. R. U.

London, Feb. 2nd, 1863.

OVERHOUSE TELEGRAPH WIRES.

To the Editor of THE ELECTRICIAN.

SIR,—We have of late heard much of the breaking down of the numerous wires which span the metropolis in all directions. I have examined a few of such wires, and found that they were thickly enveloped in rust. As we all know that the oxide is heavier than the iron which it displaces, and therefore considerably increasing the weight of the wires, would it not be desirable to have such wires coated periodically, with some kind of paint, say lamp black and oil, to preserve them from oxidation? PUBLIC SAFETY.

Telegraphic News.

THE following telegram has been received from Washington:—

"The committee on naval affairs have, according to the resolution passed unanimously on Monday, commenced an inquiry into the practicability of connecting all our naval and military stations between Fortress Monroe and New Orleans by submarine telegraph cables. Cyrus W. Field, Esq., of New York, now here, has presented to the Government an offer from the celebrated firm of Messrs. Glass, Elliott, and Co., of London, to manufacture and submerge cables connecting all the points between Washington and New Orleans. They are to be paid only on the succesful completion and delivery to the Government of the lines in good working order. In other words, they take the entire risk of manufacture, shipping across the Atlantic, laying down and working the lines, &c. The importance of such arrangements for telegraphing is admitted by all parties, both as a matter of economy and an actual military necessity. Hence there seems to be no doubt that Congress will, without unnecessary delay, make an appropriation for that purpose. The proposition received favourable consideration from the military and naval committees of the house in joint meeting."

As previously announced, the iron-cased frigate *Royal Oak*, 34, 800-horse power, preparing for sea at Chatham, has been selected by the Admiralty as the first vessel in the navy on board which Gisborne's code of steering and engine-room electric telegraph signals are to be fitted. Since the former order for applying the invention to the *Royal Oak* was issued, a second Admiralty order has been received at Chatham Dockyard directing the steering signals in addition to being placed in the engine-room and on deck, to be fitted within the armour-plated turret which is now being erected on the upper deck, and also to the two lower deck wheels, thus enabling the officer stationed within the turret to communicate his orders simultaneously to the engineer and also to the men at the wheel. This arrangement is most important during intricate navigation, such as entering or leaving harbour, or in foggy and stormy weather, it is frequently of vital importance that the captain's orders should be conveyed quickly and unmistakably to the helmsmen and engineers, and the invention enables every movement of either the helm or the engines to be apparent to the commanding officer.

THE military committee reported a resolution authorising the laying of a submarine cable from Fort Monroe to connect the Southern military stations.

Miscellanea.

THE following instances of the durability of the Ratan cane, under extremely adverse circumstances, are quoted by Mr. C. S. Duncan in a recently published prospectus relating to his method of externally covering submarine cables:—"1. A marine breakwater constructed with this material in the Eastern Seas, where the teredo and other destructive insects abound, was left perfectly untouched by them. 2. A wicker basket with a cane bottom was left by accident in a manure pit: after a lapse of six years the pit was emptied, and the basket was taken out perfectly destroyed, except the cane bottom, which was in an eminent state of preservation. 3. Cane has likewise been picked from the foul bottom of a canal near London, where it had lain for years, and yet there was not the sligtest symptom of decay. 4. For certain purposes in gas-works, iron and other wire sieves were used, but their destruction was so rapid, that after several materials had been substituted in vain, at last sieves with cane bottoms were tried, and the result has been, that they have been found to be far more durable than any other substances. It is hardly necessary to observe that if Ratan cane successfully stands these severe tests, it is not likely to be injured by the pure salt water of the seas.

THE MORSE SYSTEM OF SIGNALLING.—Since my last report this system has been extended to the South-East Coast and Ceylon, the whole Central India line from Bellary to Mirzapore, *viâ* Hydrabad, Nagpore, and Jubbulpore. Morse instruments and signallers have also been supplied to the stations of Umballa, Simla, Lahore, Murree, and Mooltan; and an office worked on this system has accompanied the camp of the Governor-General in His Excellency's recent progress through Upper India. In nearly all the offices the signallers now receive perfectly by *ear*, and reading from the paper tape is given up. The saving effected by discontinuing the use of the tape amounts to at least 30,000 rupees per annum, while twofold greater accuracy is attained in our work. Of the seventy-four Morse assistants from England, there were sixty-five in the department at the date of my last report. Since then three have returned to Europe from ill-health, four have retired on the expiration of their three years' agreement, and seven have been permitted to resign, or to accept employment in other departments of the public service. There now remain fifty-two, who are employed as shown in the annexed return No. 1. Ample proof is afforded by its details of the just and liberal treatment experienced by every one of this class who deserve promotion and reward, and that they have had a full proportion of the prize in the department. Those who have not succeeded have either to blame themselves, or have proved inferior to competitors on the list of the original local establishment. As signalling by ear is now universally adopted in America as well as in India, successful contrivances have been introduced in both countries for the simplification of the Morse instruments. The clock-work and roller mechanism for the paper tape are now discarded. For use in India I have made up a very simple and cheap instrument, which works as well as the best instruments from Berlin, at less than one-tenth of their cost. These modified instruments have, moreover, the great advantage of being dismounted, cleaned, repaired, and set up, without risk or difficulty. A complete set is made up daily in the Bangalore workshop, under the able management of Mr. Faulkner. His work is quite equal in finish and solidity to that of the best Prussian instruments.—*Sir W. O. S. Brooke, F.R.S.—Report on India Telegraphs.*

THE powerful antiseptic properties of carbolic acid have long been known, but its extended use has long been delayed owing to the difficulty experienced in obtaining it in considerable quantities. It is now, however, owing to the labours of Dr. F. Crace Calvert and others, to be obtained on a large scale, and this chemist has been the means of its application to many valuable purposes. As a medical agent it seems to have all the useful properties of creosote in an exalted degree, with some peculiar actions of its own, and is being applied with marked success in the Manchester Royal Infirmary and similar institutions, in cases of chronic diarrhœa, obstinate vomiting (even after creosote had failed), and as a disinfecting wash for ill-conditioned ulcers and gangrenous sores. It has also been applied in cases of foot-rot, which annually carries off large numbers of sheep. As the remedies hitherto adopted in this disease have been only partially successful, these experiments of Dr. Calvert, if they are confirmed in other quarters, will prove a great boon to farmers. The acid has also been applied in the preservation of gelatine solutions and preparations, of size made with starch, flour, and similar materials, and of skins, hides, and other animal substances. It also appears to act strongly as an anti-ferment, and Dr. Calvert states that it is one of the most powerful preventives of putrefaction with which he is acquainted. It is probable also that it may be found to protect timber from dry rot.

⁂ The report and balance-sheet of the Universal Private Telegraph Company is unavoidably postponed until next week.

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The Electrician.

VOL. III. No. 67.—FEBRUARY 13, 1863.

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THE SULPHATE OF COPPER BATTERY OF M. CALLAUD.

IN a recent article upon the battery of M. MINOTTO, the combination known in France and Italy as the "pile Callaud" was mentioned. In this modification of DANIELL'S battery also, the porous cell is dispensed with. A description of it, from the pen of M. BEAUNIS, will be found in the first number of the *Annales Télégraphiques*. Its original construction was as follows:—

1. A glass jar, provided with a cover, is pierced with two lateral holes for the passage of two rods of metal communicating with the negative and positive elements respectively.

2. A hollow cylinder of zinc, of somewhat smaller diameter than the interior of the glass vessel, occupies the upper portion of the latter, and carries an arm of metal which passes through the upper orifice in the jar, and is thus attached to an external binding screw, leakage being prevented by the use of washers of india rubber.

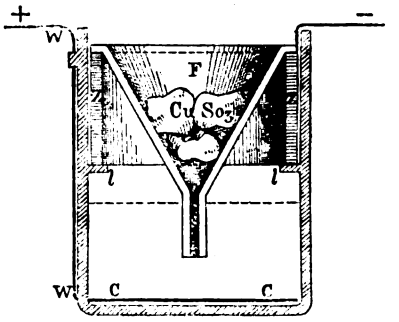
3. A ring of thin sheet copper, with an arm passing through the lower orifice in the jar, constitutes the negative element, and is fixed at a distance of three or four inches below the zinc cylinder.

4. A funnel of glass, somewhat hemispherical in shape, is supported within the cylinder of zinc, with its lower orifice at some distance above the ring of copper. Within this funnel are placed some large crystals of sulphate of copper. When the vessel is nearly filled with pure water, the sulphate gradually dissolves; and the solution, by reason of its gravity, falls to the lower part of the jar, where it is decomposed by voltaic agency, its copper becoming deposited upon the surface of the negative element.

Under these conditions, it is some time before the battery attains its maximum power. This, however, may be immediately obtained by half filling the vessel with a saturated solution of sulphate of copper, and then pouring pure water through the funnel until the jar is nearly filled.

We have found this form of battery very convenient for experimental use; and in electro-plating operations we have noticed that, under certain conditions, the expenditure of sulphate of copper may be very much reduced, without any corresponding diminution of the voltaic effect. When, for instance, in electro-plating, the zinc element is amalgamated, and dilute sulphuric acid is used as the exciting fluid, the arrangement approximates to the zinc-copper couple of VOLTA, or to the couple of WOLLASTON; but, providing the supply of sulphate of copper solution be sufficient merely to prevent the polarisation of the copper plate, an important advantage over the latter forms of battery is secured, without more than a fraction of the expenditure which takes place in the DANIELL couple. The explanation of this fact, which is of some practical moment, is that the acidulated water in this case acts almost exclusively as the electrolyte; though the polarisation by hydrogen of the copper plate, which would otherwise occur, is obviated by the presence, in small quantity, of the sulphate of copper in solution. In other instances also, we have found that the arrangement adopted by M. CALLAUD allows of a great reduction in the expenditure of sulphate of copper.

The following sketch shows a very simple and efficient method of mounting the cells. The outer vessel is constructed of gutta



EXPLANATION.—Section of battery cell, Z Z; Cylinder of zinc supported on ledge, *l l*. F, funnel of gutta percha supported on top of Z Z; C C, strip of copper passing through the side of cell, and connected to W W, a wire passing outside of battery cell; Cu So_3, crystals of sulphate of copper placed inside F; *l l*, ledge supporting cylinder of zinc should be in *middle* of jar.

percha, which allows of the passage, through the material, of the wire *w w*, constituting the positive pole of the couple. This wire may be attached to a thin disc of copper, C C, within the cell, or, by slightly heating the interior surface of the bottom of the jar, covering it with poundered plumbago, and subsequently polishing with a brush, the copper disc may be dispensed with; the plumbago, in contact with the lower extremity of *w w*, becoming quickly covered with reduced copper by the action of the battery. A ledge, *l l*, of gutta percha, is formed in the interior of the cell, and supports the zinc cylinder Z Z, to which is soldered a wire constituting the negative pole of the couple. The funnel F, supported upon the upper portion of the zinc cylinder, is best formed of gutta percha. When a battery of these cells is employed in a circuit of great resistance, one large crystal of sulphate of copper may be deposited within the funnel, and will afford a sufficient supply of the copper solution during a considerable space of time. When used on short circuit, the cell should be charged with a number of smaller crystals, which, of course, require more frequent renewal. As already intimated, the internal resistance of the cell may, when necessary, be reduced by employing dilute acid for the exciting fluid, in which case only the zinc requires amalgamation. It should be stated that the zinc element is always, more or less, subject to the deposition of copper, and requires, therefore, to be occasionally cleaned. This deposition of copper, however, occurs in very slight degree, and does not perceptibly effect the action of the battery. A syphon may be used for occasionally removing and replacing a portion of the fluid contents of the cells; and thus, with very little trouble, attention, or expenditure, a battery of this construction might be kept in continued action for a period of several years.

CONDUCTIVITY AND RESISTANCE.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 145.)

THE mind instinctively seizes upon pictorial illustrations to save itself labour. They convey to it, at once, with scarcely an effort on its part, what it could acquire from verbal description only by a comparatively protracted exercise of both memory and reason. It makes the same use of analogies. We recall to recollection things already impressed upon the mind to illustrate others we are desirous of newly impressing, through the tedious medium of phrases which need first to be comprehended, then remembered, and finally considered in perhaps many relations. No one in their senses would substitute for these processes mere analogies, but it is fortunate when the one can be accompanied by the other, as a word-picture illustrating the thing to be described. The association shortens mental labour. In my last memoir, intended to point out the natural distinction between want of

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electrical conductivity and resistance to electrical conduction, I used the analogy of water passing through a pipe, as being, up to a certain point, accurately illustrative of the passage of electricity through a wire; it is now evident that the picture I brought forward has been mistaken for an "unsound and dangerous basis" of my theory. Surely it might have been ere this perceived, from my successive writings on the subject, that my view of electrical action from first to last is based, not upon any similar action, but upon original and primary physical principles that are unquestionably applicable to electricity in the manner I have applied them. How great, then, must be the mistake that attributes them to analogy!

I thought I had made it plain to every student of electricity who reads my writings, that want of conductivity and resistance to conduction have not the same meaning, that they are not convertible terms to be used one for the other indifferently. Arguments establishing that conclusion have abundantly appeared in this journal, and their conclusiveness has in no single instance been called in question; but, notwithstanding, either from ignorance of their existence, or some other cause incomprehensible to me, further explanation is still called for, and I will therefore give it, trying to be more than ever explicit.

Imagine a homogeneous and cylindrical wire to be divided into any number of equal parts; the conductivities of all the parts will be equal; each, as a thing naturally inherent to its own particular part of the wire, being independent of all the rest. To this conclusion there seems no possibility of objection; and, it being true, it must follow from it, as a matter of course, that each of the parts can conduct an equal quantity of electricity during one and the same period of time, whenever all the parts are put to work together. Now, supposing all the parts of the wire to be working at the same time, each receiving electricity from the part next before it, and the first receiving it from an adequate source of supply; the quantity of electricity emitted in a given time by the last of the parts will then be the same, whatever the number of the parts may be,—that is to say, however long or short the wire. This argument is simple enough to be comprehended; its conclusion is evidently too necessary to be doubted; and what does it imply? manifestly this,—*that conductivity is unaffected by the length of a conductor.* It will be said, this is not in conformity with fact, for long conductors conduct more slowly than short ones. I know they do, and therein is no inconsistency, but an absolute proof of the difference I am establishing. What I have said about conductivity is certainly consistent with necessity, and nothing that the obvious principles of mechanical philosophy render necessary can be contradicted by facts. Therefore, when we see in practice that there is a something in operation which makes electrical conduction along a wire slower in some ratio of its length, we have a fact to prove that the cause of the slowness is something distinct from the want of conductivity, which is irrespective of length; and, therefore, it is in opposition to the truth whenever anyone asserts it to be "a well established fact, that no opposing force is offered to the motive tension other than the want of conductivity, or what is commonly termed the resistance of the conductor." The resistance of nature does not answer to that of the schools.

As I approve of the legitimate use of analogy I shall continue it. The same quantity of water would pass in a given time through pipes of the same calibre, however unequal their lengths, if there were not something other than the conducting capacities, as represented by the diameters, to make a difference; and that something is in its requisite measure found in friction. I at first gave the analogy as a limited one: it may be further useful to state wherein it fails; the two cases differ only in this:—Before water can move along a pipe, its inertia must have been once for all overcome, so that while it moves its velocity is only affected by friction; but when electricity moves along a wire its inertia is incessantly opposed to the motive tension, because the motion in which electrical conduction consists, is, from causes which I have long ago pointed out, commenced and ended a number of times which is greater, for each unit of quantity, as the wire is longer.

The friction of the water therefore represents the inertia of the electricity; and the two causes of resistance are further analogous in observing the same law, for they each make velocity to vary inversely as the square of the length.

I have been reminded—unnecessarily, as I hope the generality of my readers will think—that in charging a submarine wire the motive tension in the batteries generally falls; and then asked what other explanation beside that is required to account for the slow travelling of a signal. The answer is—if no other explanation be needed, nature at all events supplies another, and philosophy insists upon its being taken into account, namely, that particular resistance which is not want of conductivity, and amply sufficient to sustain unaided all demands that may be made upon it, which want of conductivity considered as resistance, is not able to do. It may be well to refer to page 326 of the "Report of the Submarine Telegraph Committee," in which, at paragraph 195, Mr. Latimer Clark showed by experiment that velocity along a given wire does not *necessarily* increase with tension. The 86th and 87th pages of the 3rd volume of the ELECTRICIAN may also be studied with advantage.

With respect to the universal practice of terminating telegraph wires by coils of comparatively fine wire my reasoning may be briefly put thus: no more electricity can come out of a conductor than can pass along it; the quantity capable of passing along it under given motive tension and resistance must be determined by its conductivity; and its conductivity as a whole cannot exceed that of its smallest section. Hence a large conductor with small ends can act no better than another conductor small throughout its entire length.* If we would have the advantage of a large conductor we must see that its size be everywhere maintained, from the charging apparatus at one of its ends to the discharging body at the other. Should we not laugh to scorn the hydraulic engineer who terminated a magnificently large conduit by ends of dwarfish calibre? But, so far as effect is concerned, and in great measure causation also, such an act would be strictly parallel to the one I am condemning, and that is to be found every day in the practice of electro-telegraphy.

Let me thank the correspondent of the ELECTRICIAN who writes under the *nom de plume* "London District," for placing his difficulties *au grand jour*, and to express to him a hope that he will continue to do so as an excellent example that a multitude of others would do well to follow. I hold myself freely at the disposal of any electrician to answer questions respecting what may be appropriately called the EQUIVALENT THEORY OF ELECTRICITY, so far as I have hitherto publicly expounded it. It is a prerogative of two doctrine tobe in no danger from fair criticism; what it has most to fear is concealed misapprehension—passive delusion. It can generally hit its mark if it be only fairly exposed to view, and should it not do so the fault will lie with him who levels the shaft and not with the instrument he is handling. Many results of experience will doubtless start forward in the minds of telegraphists that are seemingly conclusive in repudiating what has just been said, and I could anticipate them; but let it suffice to remark that I shall be prepared to meet them as they arise, and will do so until the system stands out as a perfect whole in which each part supplies something proper to itself, and that it would be premature to expect from its other elements.

[* We are bound to express our dissent from this view. Whatever may be the nature of electrical conduction—whether simple or compound—the above assertion appears in obvious contradiction to experimental fact. We may attach "small ends" of wire to the extremities of a telegraphic line without perceptibly reducing the conductivity; and we may then, by increasing the diameter of the middle portion of the line wire, improve the conductivity beyond the degree indicated by the galvanometer or electro-magnet previously to the fine wire being placed in the circuit.—ED. E.]

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THE LAYING OF SUBMARINE CABLES.

WE have much pleasure in giving insertion to the following, which is one of several letters from men of high nautical skill, which Captain Selwyn has shown to us, approving of a plan which our readers will recollect we commended to their notice in our impressions of May 30th and June 6th, last year :—

To Captain Jasper Selwyn, R.N., Chequers' Court, Tring.

DEAR SIR,—I have, with care and interest, read over your pamphlets upon the "Use of Cylinders in laying Submarine Telegraphic Cables in deep seas," and for the purpose of bringing home safely the inflammable Petroleum Oil and other liquids.

AS I have been engaged with submarine cables for the last few years, and have had some experience in towing at sea, I feel happy in contributing my small share of testimony in favour of an object, which, I have every reason to believe, will become of valuable importance.

In the first place, every one who has had the shortest experience at sea, must know that the *only safe* means of running out lines clear is from a reel, hence the use of it for the log line, deep-sea sounding, and other lines, in daily use. The use of the reel, then, is universal. Try to run out a supple sounding-line from a coil, or long fakes, and it will be liable to foul or kink. How much more, then, is it likely, that an unhandy and stiff cable will do both? During the whole of my time I have invariably had to pay cables out from coils in a ship's hold, and I do not remember a single instance of its having been accomplished without having either to contend with broken wires, foul fakes, or kinks. If the first are allowed to get to the fair leader to the drum, or to the guiding knife *on* the drum, it rips up the wire in a few yards to an immense size, jams the turns on the drum, and brings everything to a dead lock; if the ship is not stopped, and sharply turned astern, in time to slacken or ease the cable, something must break, or bring such a fearful strain upon the cable, or paying-out machinery, as must materially damage one or both. If the cable does *not* break, it *must* bear such a strain as will considerably elongate it, and try the core to such an extent as to cause frightful damage, if not utterly to ruin that particular length of cable, which might, after being submerged, show such faults that would (being unrecoverable in deep water) prove the entire loss of the whole cable. If a foul fake comes up the hatchway from neglecting to cut a stop, or other causes, your leading ring is broken, the V sheave supports carried away, and a general wreck takes place, if the vessel be not immediately stopped. A kink may pass along, and go out quietly over the stern into the sea, but it will tell its after tale of damage or annihilation. All these dangerous contingencies would entirely be obviated by using the cylinder. We should have no changing watch of about fifty men every two or four hours (look at the expense of more than double crews), no foul fakes, no kinks; and if a broken wire *should* by accident occur, it would pass off the cylinder unmolested, and unmolesting, into the sea; there would be no sharp order for stopping the engines, turning full power astern, with the risk of the cable becoming foul of the screw; or, if a paddle-boat, the rudder; no clapping on the breaks, if not to breaking, to flattening power, jamming the very heart of the core till the tar oozes out between the iron strands; no confused rushing aft to clear away the buoys, or clapping on the stoppers; no giving orders to do impossible things, and a thousand other inconsistencies that are only obvious to those who, by hard experience, know what such things are; there would be no flying of the ship's stern up to windward when stopping for a mishap, bringing the poor unfortunate cable dead across the stern, with a grinding strain over the sharp lip edge of a V sheave that makes even those who have been accustomed to it hold their breath in expectation of seeing the cable part, and all their hopes of success at once frustrated. For one must remember that when once there is a jam or stoppage for repair, that there is no easing the cable, or surging up; but the vessel must ride by it, and woe betide it in a breeze of wind and beam sea—if by good luck the cable holds her, away goes the vessel's head, dead to leeward drifting—where? By the time everything is ready to recommence paying out the cable, and the ship's head once more brought to her course, how many *miles* of cable have been expended—*wasted*—*uselessly wasted!* Let shareholders think of, and look to, this; these are a few of the many difficulties which the practical man has to encounter in laying cables from out of a ship's hold. Then, as to buoying a cable for a fault, which it would be impracticable to repair at the time; or having to buoy an end for cutting in a gale of wind, the ship being unable to pay out; or in the event of a ship's engines breaking down, or other contingencies, which, at the commencement of the undertaking, it is impossible to foresee; these, one and all, would be obviated and done away with, by using your self-acting cylinder, which could at any time be cast off for the purpose of repairing a fault; or, in the event of such a gale of wind as would prevent the steamer from towing, the cylinder would ride by the cable, paying out only such a quantity of cable as would ease the strain, the paddles of the cylinder acting as a gentle but important break, as shown in the able pamphlet you so clearly put before the public. Again, a very great and most important object is gained by the employment of the cylinder, namely, the ship's compasses are, comparatively speaking, uninfluenced. None but those who have experienced it, can imagine the effect which paying out a cable from different parts of a ship; and along her length, has upon the steering compasses; and when taking into consideration that the slightest deviation from her course involves a much larger expenditure of cable than the uninitiated can imagine, it is well worth serious consideration; and when every mile uselessly paid out is as so much capital thrown into the sea, its consequence should not be passed over as a thing of nought. The cable on the cylinder, towing some hundred feet astern, would have but little effect upon the compasses of the steamer towing; and if it had, it would be uniform and known, instead of ever-changing and unascertainable. The above remarks are more especially intended for iron wire covered cables; but it is to be hoped that the days are numbered for such monstrosities to appear. Except for shore ends—if my humble opinion may lend even the smallest weight to those of my brother officers, I hesitate not in saying that I am in favour of a light cable, though of sufficient specific gravity for sinking at a moderate rate, in deep water, to escape the influences of surface currents. And I would like to have its strength in the *interior*, like Allan's conductor, and insulated by Hall and Wells' india rubber, so much approved of by the commission appointed by the Board of Trade. (*Vide* Government Report, pp. xxviii. and 389.) The outer covering I would leave for further consideration, as new forms are being brought forward every day; but for outer preservation, I have a high opinion of Hays' marine glue. A well approved cable, coming from the maker's hands at once on to the cylinder, moored off his factory, coiled on either by the tide or machinery, and from that moment exposed to water, is, I consider, one of the greatest objects to be attained towards the successful preparation for submerging long deep-sea cables. The inner end of cable (as shown in your excellent model) can always be connected up, by a well insulated wire, with the batteries and instruments in the ship, thus affording the happiest means of properly and *efficiently* testing the cable from the moment it leaves its maker's hands. You have provided for this, and this is (and must be acknowledged by all) *the one thing needful.* The provision you have made for towing the cylinder, for reversing it to recover cable, for recording the number of revolutions, for reefing the paddle floats, and, as the cylinder becomes lighter, for expanding them are admirable. And the clever contrivance of yours for catching the cable some distance astern, in the event of its breaking, and retaining it by a buoy, is excellent. The advantages of being able to cast off the cylinder in the event of a gale of wind, and retake it in tow, is of vital importance for the saving of the cable in mid-ocean; in fact, almost every situation or difficulty can be provided for and against, at sea, by the use of the cylinder, for the safety of the cable, and protecting it against the slightest external injury, which could *not* be done were it coiled *on board* ship, as it was in H.M.S. *Agamemnon.*

And now for a few words as to the towing question. The general public imagine the towing of a body to be a laborious and heavy task, a great deal more so than it really is. The youngster, in his first voyage to sea, begins his experience in towing; this he learns in watering ship at many of our islands; his spell with the watering gang teaches him to raft casks, and he finds out the different degree of resistance in light floating (empty) casks, and deep-laden full ones, just awash; and by tugging at the oar, he learns the power required in towing, from the launch to the jolly-boat, and what it is to tow in smooth water in a swell, in a tide way, and often in a lump of a sea, when clear of the sheltering point of land. And, as he remains at sea, so do fresh and greater opportunities occur, to give experience in the art; yes, *art* of towing. We find, to tow steadily, the body towed must follow *right* in the wake, and that the towing lines must be separated to the beam of the body towed, instead of leading to the apex or point; thus it is, that if a seaman is in a steam-tug, towing a vessel, he will request them to sprit-sail yard his warps, or take them through his fore-chain ports instead of through his bow-hawse pipes, which makes her yaw about, spoils the steering of the tower, and stops her way. If he is towing the above-named water cask, he would wish it could revolve, for it would then take off a large portion of the resistance, and would enable him to finish his task of towing in

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half the time. In these two simple illustrations, the cylinder proves her capacity and great facilities for towing. And, as to the fears often entertained by landsmen, as to the feasibility of towing *large* bodies *at sea*, or of one ship towing another, I can only give you my own experience. In the beginning of 1855 (I then being in the Indian Navy), I was appointed Naval Transport Agent on board the ships engaged to convey H.M. 12th Lancers from Bombay and Mangalore to Suez, *en route* to the Crimea. They embarked on board the old East Indiaman *Charles Grant*, one of the original tea-waggons, more resembling a tea-chest than a ship of the present day; she was of large tonnage, short, and very high out of the water, with as bluff a bow as needs be. We took on board as many of the troopers' horses, and baggage as we could stow away, and the remainder were put on board the Peninsular and Oriental Company's steam-ship *Pottinger*, one of their small original paddle-boats, and she took this old clumbunky in tow, and with ease towed us the whole way to Suez, and back to Bombay, without once casting us off, except to coal at Aden. We encountered head winds, and winds abeam, long swells, and short chopping seas; in fact, all kinds of winds and seas incidental to a voyage of some twenty days in that part of the world; but away we sped, averaging about two-thirds or more of the *Pottinger's* usual speed, when without any tow, and in good trim. On our return voyage, the *Charles Grant* was flying light, showing an immense broadside to a heavy breeze before the beam; but the only great impediment we experienced was the wear and tear upon our warps. At the same time the *Prince of Wales* Indiaman was towed by the Peninsular and Oriental Company's steamer *Malta*, and other vessels, with H.M. 10th Hussars, for the same destination. I think I have by me somewhere a copy of log, that I sent in to the Commander-in-Chief of the Indian Navy; if so, you shall have it; but in the event of my having left it among my papers in India, I have no doubt but that the Board of Directors of the Peninsular and Oriental Company would courteously grant me an opportunity of taking extracts from the log of their steamship *Pottinger*, for your information, with the view of giving data upon a good work.

I have no doubt many officers of the Royal Navy can, and will, give numberless instances of H.M. line-of-battle ships being towed by comparative small steamers during the Crimean War.

I have, therefore, no hesitation in giving my cordial support for the adoption of the cylinder to lay telegraph cables, as I really and truly believe that it is *the* method, and the only *honestly safe* method, for laying cables; and this opinion, I feel confident, would be verified if gentlemen interested in submarine telegraphy would but give an experimental trial of the cylinder, by having one made, and on it coiled some old iron-wire rigging, to be paid out in the Bay of Biscay, or off the bank of soundings, at the chops of the Channel. Before concluding these few of many remarks that could be brought to bear upon this subject, I will show the great saving that would result from the use of the cylinder. In a ship—you must have one built for the purpose, or go to the tremendous expense of having her holds fitted for the reception of the cable coils, by removing stanchions and beams, building tanks for the cable to be coiled in for constant testing (and woe betide these, when rolling heavily in a gale of wind), the decks are ruined, by being cut up for heavy paying-out machinery, the wear and tear of which only can be known by experience (inquire of the officers of the *Agamemnon*). Then there is the heating of the hold, the chances of damage to cable in coiling and uncoiling, the chances of cable shifting when vessel rolls heavily, straining her fore and aft, and accidents, whether purely so, or malicious. Treble the crew, their wages and provisions; and what with the changes of coils from forward to aft, and gun deck to orlop, the constant change of watches for the men, and a thousand other incidents too many to be enumerated, but still existing, there is a combination of anxieties which must ever attend the responsible parties entrusted with the paying out a cable from a ship. With the cylinder, the first expense is the only great one; though that is only one-fourth of what a ship would cost; and when once fairly started with the cable, testing satisfactorily from end to end, come fair weather or foul, you have your ship free, your cable on a vessel that will never strain it, nor founder with it; there will be no shifting, no accidents, no fear of too much brake power, and no heart-wearing anxieties that *must* exist when the cable is *in*side the ship instead of out. I will now conclude, by wishing you heartily every success; and if I am permitted to witness its trial on the broad Atlantic, I feel certain I shall have the pleasure of congratulating you on your triumph; BUT on the sea, it (the cylinder work) *must* be consigned to your management, assisted by nautical men, and *not* to civil engineers and electricians, who will have quite sufficient to occupy their minds and time in filling their own legitimate spheres.—I remain, my dear Captain Selwyn, very faithfully yours, THOS. TRIDE.

34, Harleyford Place, Kennington Park, S. January 28th, 1863.

ON THE APPLICATION OF SCIENCE TO ELECTRO-PLATE MANUFACTURES.

(Continued from page 157)

No important improvement in the electro-deposition of silver has since been made; and the process at present in use may be briefly described as follows:—A certain quantity of pure or virgin silver in a granulated state is taken, allowing about one ounce for each gallon of plating-solution required (the actual proportions, however, in use by manufacturers vary from a quarter of an ounce to two or three ounces of silver per gallon), a warm mixture of four parts of pure and strong nitric acid, and one part of water, contained in a capacious vessel of glass or stoneware, is placed in a warm situation, where the air-fumes may readily escape without injuring persons or furniture; and small quantities of the silver are added, from time to time, as fast as it dissolves, care being taken not to add it in too large quantities at a time—otherwise waste will ensue—until nearly all the silver is dissolved. It is advisable to employ a deficiency of the acid mixture in the first place, and to add more of it towards the end of the process, taking care not to add more than will dissolve all the silver, but rather to leave a little silver undissolved, even with the liquid quite hot; by this means, the presence of much free acid is avoided, and an after loss of cyanide of potassium and escape of poisonous fumes of prussic acid prevented. Each ounce of silver requires nearly one and three-quarter ounces of strong nitric acid to dissolve it.

The solution of nitrate of silver obtained is now considerably diluted with *distilled* water in a capacious vessel of stoneware, and there is added to it, in portions at a time, with stirring, a solution of cyanide of potassium of moderate strength as long as a white precipitate or cloud, which is cyanide of silver, is produced; this precipitate is allowed to subside between each addition, and it is very particular that as the precipitate produced becomes less copious the cyanide of potassium solution should be added more sparingly and at longer intervals of time, and that on no account should that liquid be added after it fails to produce a precipitate. This point requires some care and experience, but may be known by the cyanide of potassium solution producing a *transparent* but slightly brown appearance where it passes into the white and cloudy liquid; this transparency is caused by its dissolving the suspended fine particles of cyanide of silver; if by accident too much cyanide of potassium has been added, a cautious addition of dilute nitrate of silver solution (for which purpose a little should be reserved) in a similar manner, will bring it back to the neutral or proper point; the whole is then well stirred and allowed to subside until the supernatant liquid is quite clear. Each ounce of silver dissolved requires nearly half an ounce of cyanide of potassium of ordinary quality to precipitate it.

The supernatant liquid is then filtered through a calico bag, the sediment put into the bag, and the bag filled five or six times successively with spring water. A small quantity of hydrochloric acid is added to the filtered liquid to precipitate any dissolved silver (of which there is always more or less), in the form of chloride of silver; this is allowed to subside, the clear liquid is thrown away, and the sediment retained on account of its silver.

Now, the wet contents of the filter are transferred to a capacious vessel, and to it is added, with constant stirring, a strong solution of cyanide of potassium until it is all dissolved, a memorandum of how much cyanide of potassium is used being made, because the amount varies greatly in different cases, and is dependent upon the quality of that substance. If the cyanide of potassium is of ordinary quality, each ounce of silver employed will require about two or two and a half ounces of cyanide of potassium to re-dissolve it; whatever the quantity required to re-dissolve the cyanide of silver may be, an equal additional amount should now be added to the mixture to constitute *free* cyanide, and sufficient water then added to dilute the solution to the proportion of one ounce of silver per gallon, or any other strength that may be desired; the solution now only requires to be filtered, and it is ready for use.

In coating articles with silver by means of this liquid a voltaic battery is employed; the battery varies in its arrangement in different establishments and in different cases, but always contains dilute sulphuric acid and plates or bars of zinc. The battery most commonly used consists of a sheet of copper and a plate of amalgamated zinc immersed in a mixture of oil of vitriol and water contained in a large stoneware jar; the zinc plate is connected by a copper wire with the articles to be coated, and the sheet of copper is connected by another copper wire with a sheet of pure silver, which is hung in the plating-solution near the articles. In this arrangement the electricity is generated by the action of the acid and water upon the surface of the zinc, and passes from the zinc through that liquid to the sheet of copper,

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then along the copper wire to the sheet of silver, then through the plating-liquid to the articles to be coated, and back to the zinc plate by the other copper wire.

The electricity in passing from the surface of the sheet of silver into the plating-liquid causes the cyanide of potassium to act upon that metal and dissolve it, and at the same time the electricity passing into the surface of the articles decomposes the solution in contact with them, and causes it to yield up its silver to those surfaces; and these two simultaneous actions are perfectly equal in amount, *i. e.*, for every ounce of silver dissolved on one side an ounce of silver is deposited on the other, and thus the amount of silver in solution remains unaltered for an indefinitely long period. The only alteration that takes place in the liquid is that it becomes unequal in composition in different parts —that portion of it about the dissolving-plate becomes richer in silver and specifically heavier, and therefore sinks to the bottom of the vat, whilst that about the articles becomes poorer in silver, specifically lighter, and rises to the surface; and this inequality renders it necessary to stir the liquid occasionally, otherwise the quality of the metal deposited upon the articles would be different at the upper ends to what it is at their lower ones.

In most electro-plating establishments, two or three such battery-cells as those described are used for depositing silver, and in the early period of plating a much larger number was used. When several cells are employed, the zinc plate of the first one is connected by a wire with the copper of the next, and so on throughout the series, leaving the extreme copper at one end and the extreme zinc of the other to be connected with the vat in the manner described; by this means there is a course opened throughout for the electricity to circulate, and each additional cell or pair of plates imparts an additional impulse to the electric current.

Several other kinds of voltaic batteries, besides the one described, are also extensively used in electro-deposition; there is Smee's battery, which contains a sheet of platinized silver instead of the sheet of copper; Grove's, which consists of amalgamated zinc in dilute sulphuric acid and a sheet of platinum in strong nitric acid, the two liquids being kept from mixing freely, but allowed to touch each other by means of a separating diaphragm or cell of unglazed (*i.e.*, porous) earthenware; and Bunsen's battery, which is similar to Grove's; graphite (obtained from gas retorts) being, however, employed instead of the sheet of platinum. Daniell's battery, which consists of amalgamated zinc in dilute sulphuric acid, and copper in a solution of sulphate of copper, the two liquids being separated by a porous partition, is not much used for electro-plating; and the preference of one battery over another for electro-deposition depends partly upon the bias of the plater in favour of that particular battery, but chiefly upon the special purpose for which the battery is intended; in cases where great resistance is offered to the passage of the electric current, as in solutions for coating articles of iron, &c., with brass, the more powerful batteries of Grove and Bunsen are used. Whichever of these batteries is employed, and whatever may be the metal intended to be deposited, the article to receive the coating is always connected with the *zinc* plate of the battery, and the metal to be dissolved is connected with the copper, silver, carbon, or platinum, as the case may be.

All metallic articles that are to be coated with silver or other metals by electro-process require to be perfectly cleaned and prepared before being placed in the plating-liquid, otherwise the metal deposited upon them will not adhere properly. To clean them, they are at first immersed in a boiling solution of caustic potash to remove greasy and tarry matters; then, if they are formed of German silver, brass, or copper, they are washed in water, dipped momentarily into aquafortis, again washed in water, then dipped into a very dilute solution either of nitrate of mercury or of cyanide of mercury and potassium, and immersed in the silver-plating vat. In cases where it is desired to know the quantity of silver deposited upon them, they are weighed after cleansing, and also at intervals during the process of deposition. Articles formed of Britannia metal, lead, tin, and similar metals or alloys, are not dipped into aquafortis, but immersed in a weak silver solution immediately from the caustic potash liquid, to receive a thin preparatory electro-coating, and then transferred to the ordinary silver vat. The thickness of silver deposited upon articles is frequently very minute, as may be judged from the fact that full-sized iron snuffers are sometimes wholly coated with silver for two-pence each pair, and other common articles at proportionate prices.

After receiving the coating of silver, much remains to be done to the articles before they assume a saleable condition, they have to be "scratched" by a bundle of revolving fine brass wires to remove asperities; burnished to make them bright; in some cases, they have to be "oxidized" in particular parts. This consists in wetting those parts with a solution of bichloride of platinum, which blackens those portions; and, in other cases, different parts, as, for instance, the interior of cream-jugs, sugar-basins, &c., have to be electro-gilded. And in cases where portions of the exterior have to be gilded, the remaining surface is coated with copal varnish, to prevent the gilding from taking place on those parts. And, finally, the articles are washed in clean water, and at once immersed in hot, dry sawdust, which absorbs the moisture and dries them quickly, before they have time to tarnish. The processes of preparing and finishing articles are, in nearly all cases, much more troublesome than that of plating itself.

These various points of information are only the *outlines* of the process of electro-plating, and for the details the reader is referred to the various published works on the subject.

The scientific perfection of electro-deposition consists in its definite mathematical character. Under carefully prepared conditions, all the chemical actions that occur in the battery and plating-vat stand in certain precise mathematical relations to each other; for every 32½ parts of zinc dissolved in each cell of the battery, there are 108 parts of silver dissolved and 108 parts deposited in the vat; or, if it be a copper solution, 31¾ parts of copper, or an antimony solution, 40 parts of antimony; for every 32½ parts of zinc dissolved in the battery, there are 9 parts of water decomposed; and if it be a Smee's, or a common zinc and copper cell, there is one part of hydrogen set free at the negative silver or copper plate; and similarly with all the chemical actions taking place in the various battery-cells and depositing liquids. Each action in a given circuit stands in a certain mathematical relation to each and all the others, and this is known as the law of "definite electro-chemical action."

The artistic advantage of electro-deposition consists in the great facilities it affords for the exercise of taste and design, and for more accurately imitating the forms of nature, as in rocks, animals, fruits, trees, &c. And its domestic utility and household economy consist in the greater degree of cleanliness and beauty obtained at so moderate a cost.

As long as arts and manufactures are left to be directed and improved by simple experience, their progress is extremely slow; but directly scientific knowledge is successfully applied to them, they advance with astonishing speed. For years the manufacture of plated metal wares existed without making any material progress; but, on the application of science, its progress became surprising, and called the attention of all persons to the new process.

Thirty years ago electro-plating for commercial purposes was unknown; but as soon as Jacobi and Spencer made known the results of their electrical experiments upon metallic solutions, the manufacture of plated wares began to advance; and so rapid has been its progress, that, at the present time, thousands of persons are employed in it, and electro-plate productions are used in all parts of the world.

Thus it is that man, to some extent the servant, but hoping to become more the master of nature, is daily striving to acquire a greater knowledge of the workings of natural forces, and to apply those forces to human benefit; he first becomes the obedient disciple of nature, in order that he may ultimately become its director; and so great a degree of success has already resulted from this course, that we are justified in expecting that, at some future time, science will extend its helping hand to all trades and manufactures, and that, ultimately, scientific principles will be universally recognised as the great "regulators of productive industry."

MR. T. A. MASEY'S PAPER ON THE SUBMARINE TELEGRAPH.

DISCUSSION AT THE SOCIETY OF ARTS, JANUARY 28, 1863.

The CHAIRMAN said it was now his duty to invite discussion upon the very interesting historical account of the Submarine Telegraph with which they had been favoured this evening. He was old enough to recollect the time when not only submarine telegraphs, but electric telegraphy itself, was a matter of doubt, when grave reasons were advanced, which appeared very plausible at the time, against the electric telegraph being in any sense practicable. The difficulties of insulation, the resistances of long lengths of wires, and the difficulty of obtaining an insulating medium which would not only resist the effects of time, but also the liability to fracture, seemed to render it problematic whether they should ever succeed with the electric telegraph at all. They were, however, now so accustomed to this mode of communication, that they had long ceased to think of the difficulties which attended its first introduction, and they were now extending their lines further and further, till they had not only established the electric telegraph as a means of land communication over an enor-

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mous network of territory (and up to this time he had imagined it had been carried to a greater extent than the 6,300 miles mentioned in the paper, although this was a considerable distance, looking at the comparative short period during which the system had been in existence), but they had also very long distances of submarine telegraphs; and they had practically established the fact that it was possible to communicate signals across the Atlantic, a distance of about 2,000 miles. If they could effect the successful laying of the cable, there was nothing to prevent the communication of signals through that length of submarine wire. The difficulty had now become comparatively small, for as soon as it was known that the result could be affected, the rendering of that result of a more permanent character was only a work of time. There were two questions which appeared to be the principal ones opened for discussion by the paper: one was the best practical route to be adopted. Mr. Masey had expressed an opinion in favour of the direct route from Valentia to Newfoundland. There were many other persons who considered the route by Iceland and Greenland presented advantages over that from the coast of Ireland to Newfoundland. With regard to the Iceland route, objections had been mentioned in the paper respecting the magnetic influences which might be exercised upon the telegraph by the aurora borealis in those regions; but it had not been explained why those influences should exist to a greater extent in the Iceland route than in the other. It was true that the aurora borealis was supposed to have increased effect the nearer they approached the poles, but at the same time the difference of latitude between London and Iceland was so small that they could hardly suppose that the influences of those currents would have any greatly increased effect. He did not know whether experiments had been made on a sufficiently large scale to prove that that phenomenon exercised the effects upon the wire which were ascribed to it, and he was quite sure many gentlemen present would be glad to receive some further information on that subject. If it should be found that the fears on this head were groundless, by the adoption of the Iceland route the line would be divided into three great divisions, so that if an accident occurred they would have only one-third of the line to deal with. Another subject which had occupied the attention of all electricians was the means of insulating and protecting the conducting wire. Had it not been for the discovery of gutta percha, they would now be a good way off the point of perfection at which they had at present arrived in electric telegraphs. Gutta percha had been proved to be a good insulator; it was elastic, but not to too great an extent, and was capable of sustaining the influences of time and exposure under water without injury, and would bear a great amount of pressure without cracking like glass or pitch, and it was, upon the whole, a very appropriate medium of insulation. It seemed to have come just in time to enable us to carry out those discoveries which had been made in submarine telegraphy. In addition to this, they had a second element of consideration, viz., the means of protecting the insulated core of the cable by an outer covering of iron wire or other material to preserve it from injury after it had been submerged. The larger the amount of information that could be gained on these subjects the better, seeing that another attempt would, in all probability, be made ere long to carry a cable across the Atlantic, and he hoped this discussion would result in information of a valuable and practical character being imparted on these highly important subjects.

Rear-Admiral ELLIOTT would not have ventured to address the meeting on this subject were it not that he considered it to consist of two distinct elements, the scientific element and the practical element; and upon the latter, which had reference to the laying of the cable after it was completed, he thought he might be allowed to form some opinion. He had heard with the greatest pleasure the very able paper which had been read that evening, but there were one or two points on which he differed from Mr. Masey, and it was but fair that he should express them at once. There was one point which he thought had been omitted altogether. With regard to the failure in the laying down of the Atlantic cable different reasons had been assigned; but he thought the practical reason of this failure was that the weight of the cable was so great, that if the cable itself had been perfect in a scientific point of view, in a practical point of view it would have been destroyed by its own weight, and he thought if the cable before them (a thick one) was that which it was proposed to lay down on a future occasion, he feared that its own weight would destroy it. He would not say one word in disparagement of the Atlantic Telegraph Company; on the contrary, he thought they were deserving of all honour as pioneers in this undertaking, and their persevering efforts to repeat the experiment after the misfortune that befel them deserved the greatest credit; but there was a wide field open for other undertakings of the kind, and any other company which sought to carry out the same object ought to regard with a favourable eye the exertions of the Atlantic Telegraph Company, and, benefiting by past experience, he hoped they would go hand in hand with them. The field was large enough for all. If twenty cables were laid down, he hardly thought they would be able to supply the demand. It had been mentioned by Mr. Masey that another cable was being formed by a new company, and he truly gave, to a certain extent, the projects of that company, but he was mistaken on some points. In the first place, it was true that the proposed route was not the same as that which had been taken by the Atlantic Telegraph Company. It was to leave Brest and to touch at the Island of St. Pierre. He believed that the French Government had regarded that route favourably, and had given a concession for the lengthened period of fifty years, and that a subvention would be granted, so that he trusted that company would soon be in honourable competition with the Atlantic Company; and if both succeeded, there would still be room for many more cables. It had been lately proposed that a survey should be made previous to any other undertaking being previously commenced; and he had recently heard a paper read before another society, in which it was proposed that a belt of five miles across the Atlantic should be surveyed, which should be completed before any other cable was laid down, and he understood that application had been made to the Government for the grant of vessels for that survey. On the occasion to which he referred he saw a line laid down on a map representing the line of soundings which Captain Dayman took across the Atlantic. He was of opinion that if they could make an accurate survey of a belt of five miles, and if they could ensure that the vessels laying the cable could keep that line, it might be desirable to delay the operations till that survey was made; but he believed if a vessel started from the coast of Ireland with the best navigators in the world, and the best instruments that could be obtained, it would be totally impossible to keep within that belt of five miles. The action of the wind and the currents, and other influences, made it almost impossible for a vessel to be kept within that belt; and even if this could be done, it was questionable whether such a survey would render it possible to avoid the inequalities of the bottom, so as to prevent injury to the cable. With regard to the cable itself, he had conversed with a great number of electricians, the most scientific men of the day; and it appeared to him that the scientific element was further advanced than the practical element. They approached very near to agreement with regard to the core of the cable, but when they came to the strain upon that core, and to the protecting covering of the cable, they all seemed to disagree. He had already said he believed the great weight of the cable was an element of self-destruction, and that another cable of the same kind would be destroyed by the same means, even if the most perfect results in the manufacture were secured. He thought he might say it was owing to the failure of the first cable that a second company had been projected whose object was to employ a cable of less specific gravity, and he did not see what possible objection there could be to it. The question of the outer covering of the cable was one which he was most anxious to see satisfactorily determined. If it could be proved that beyond a certain depth the cable did not require protection from marine insects, the difficulty could easily be got over; but when they came to question the men of science of the day, none of them would say that the cable was not liable to the attacks of those insects, and they knew if worms were there they would eat the hempen covering of a cable into shreds. He felt certain, therefore, there must be some better kind of protection for the cable; he considered iron was too weighty for the purpose, and at certain depths, instead of adding to the strength of the cable, it was in itself an element of weakness, because the greater the weight the greater the power of the momentum would be, and the heavier the cable was the greater would be the strain upon it in paying it out. Professor Wheatstone had prepared a cable which might be laid at the bottom of the sea, and answer all practical purposes, and would cost only half the amount of the former cable, if only they could be satisfied that it would be secure from the attacks of insects; but they knew that crabs and other marine animals had been brought up from great depths; and a gentleman in Paris had produced a glass of sulphate of copper with a long living worm in it, notwithstanding it had been supposed hitherto that sulphate of copper was the best preservative of hemp from the attacks of those insects. He was therefore brought to the conclusion, that if an outer covering were required for the cable, it must be a metallic one.

Dr. WALLICH said, although he was prepared to afford all the information he could with reference to the deep-sea bed, he had no idea that he should be called upon to defend some propositions which had been laid by him before the Geographical Society. The main fact with which he started was this, that the evidence with regard to the nature and contour of the deep-sea bed was wholly inadequate to the

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requirements of ocean telegraphy. Two lines of survey of the Atlantic had already been made, one by Lieutenant Berryman, and the other by Captain Dayman. That of Lieutenant Berryman was unfortunately found to be untrustworthy. The committee of the United States navy gave a distinct opinion that the discrepancies between the log, the chart, and the report were so great, that the line of soundings could not be relied upon. We had, therefore, to fall back upon the single line of survey taken by one of our own naval officers, Captain Dayman, but when he mentioned that in an area extending over 1,300 greographical miles, only 41 soundings were taken at intervals of from 30 to 70 geographical miles, everyone must be aware that in those intervals where no soundings were taken, alterations of level might exist of sufficient extent to be dangerous and fatal to a cable. He had lately brought before the Geographical Society a proposition which was intended to obviate the insufficiency of the surveys already made. Even if Captain Dayman's line of sounding were considered sufficient—if the cable could be laid absolutely along that line, he should like to know how the ship which was to pay out the cable could follow accurately in the wake of the ship in which the survey was taken? To obviate this he proposed that a belt, not of five miles, but of two miles, should be surveyed. The question had been raised that evening whether it was practicable for a ship to be kept within the course of a belt across an extensive area like the Atlantic. Having read an extract from the report of Sir Leopold McClintock on this subject, which favoured the view that a ship could be kept within the two mile belt, Dr. Wallich added, that what he proposed was, that two vessels should undertake the survey of a belt of two miles across the Atlantic, to sail in parallel courses, and to take alternate soundings at five mile intervals, so that when the intervals were five miles, the diagonal intervals between the soundings on the two opposite lines would be only about two miles and a half, so that instead of intervals of 40 miles he proposed intervals of only 2½ miles, and in the place of 41 soundings, there should be 700 soundings, which could be accomplished in about five months and a half, at the rate of about three soundings per day. He would put it to the meeting whether it would not be more satisfactory to await the results of such a survey as he had suggested before consigning another half million of money to the bottom of the Atlantic?

Admiral Sir E. BELCHER wished to offer a few observations on several of the subjects which had been started. First with regard to the aurora. In the year 1825, when employed in Behring's Straits, with the late Admiral Beechey, every effort was made to trace the disturbance of the magnetic needle during the most brilliant exhibitions of the aurora, but without detecting the most minute disturbance. In the last Arctic search by Government, the most delicate magnetometers, acting precisely as those described by Mr. Masey, by reflection over great arcs, were used over two years, with observers noting every 2½ minutes during the dark season for disturbances generally. Many disturbances were noted, but none were detected during the visits of the aurora. He, therefore, refused to give any credit to the statement that the aurora produced an electric disturbance in cables under water. Next, as to the course to be selected for laying the cable. If it was to be laid on the shortest line, that by great circle sailing was the best, and he was satisfied that by adopting the apparent northerly arc from the Faroe Islands, skirting Iceland and Greenland, the actual distance would be shortened between the extreme land ends in comparison with that proposed hitherto, by at least 250 miles. Then as to deep-sea soundings. Landsmen imagined it a very simple operation; naval surveyors knew to the contrary. It was supposed to be a very simple act to throw overboard a lead with line attached, and to reach the bottom vertically. But so faulty was this mode, that Massey, Burt, Ericsson and others invented machines by which the actual vertical passage of the lead alone was measured. But this demanded that three times the length of slack should be thrown overboard, and no positive sensation as to when the lead first struck ground was obtained; consequently, in the case of a lead striking on a steep incline, it might afterwards slide down to the bottom, and no indication whatever of a peak, even close to the surface, could be obtained. But another important problem was involved. It was generally imagined that currents were merely superficial. That was a grave error, and one well recorded fact was worth a thousand assertions or theories. Some of his officers were there present who had taken part in delicate operations of this nature, and would speak for themselves. The very important duty had been especially entrusted to him by Government, "to determine at what depth the strongest currents begin to vary." He selected a calm, when about ten miles off the Cape de Verd, on the coast of Africa, where a five-knot current ran. Five boats were lowered, with lines of 200, 400, 600, 800, and 1,000 fathoms respectively; a deep-sea lead of 28 lbs. in a basket was attached to each, and each line buoyed by a cask, with a flag-staff and flag, in order to measure their positions relatively with each other as to drift. The ship had the deep-sea sounding bottle attached at 1,200 fathoms. At the expiration of two hours the whole had drifted ten miles past the Cape, but the ship and boats were nearly relatively in their same positions. Therefore, as deep as 1,200 fathoms, the current ran with the same velocity. There were many other cases which he would pass over. In 1838, when perfectly calm, the water bottle and other thermometers were sent down in 1,200 fathoms off the Galapagos, on the Equator, in the Pacific. The line was perpendicular, yet the ship was drifting swiftly past the islands. In both these cases reliable landmarks were available to determine the rate of drift; but, at sea, who could determine this? Now, as to the rate of descent, it would be found (see p. 796, *Nautical Magazine*, 1843), that it required 2 hours, 13 minutes, 22 seconds, for a lead of 12 lbs., with a fine whipcord line attached, to decend 3,000 fathoms. What would a mere 28lb. lead require with a line strong enough to recover it, and what time would be consumed in hauling it in steadily to prevent jarring, as well as stopping to disengage thermometers, if the operation was to be accompanied by scientific research? It was all very well to talk about scientific officers, and scientific observers, but who could test their value? With a set of ten observers, even with the simple observation at noon for the latitude, he had witnessed miles of discrepancy, and when it came to fix positions—hours before or after noon—he felt no confidence in any observer. It was all mere guess-work; therefore the idea of following out any given lines on the pathless ocean was a mere speculative dream. If they required the true survey of the line between the two continents, to lay down the cable, let them attach very slender lines at certain distances, with floating reels, and let a small vessel follow and pick them up, noting each true depth, but losing the lines. He had used the simple cotton reels, containing 200 yards, or 100 fathoms each, adding others as the depth required, and obtained truer soundings than the great lead line would effect. The length of the lines supplied by Government for this purpose exceeded the circumference of the globe, and yet the cost did not exceed £15. That, therefore, was the cheapest as well as the only mode by which any reliable survey of a line across the Atlantic could be effected. If we had enough data for laying down these electric cables, he saw no reason to incur such enormous expense by mapping the Atlantic, and blotting our charts with soundings, which were placed merely at haphazard.

Colonel SHAFFNER rose for the purpose of correcting one or two errors contained in the paper. On behalf of his countryman Mr. Morse, he might be permitted to correct the statements of Mr. Masey with regard to the dates of that gentleman's inventions. Credit had been given to Mr. Morse for inventing his process of telegraphing in 1843, whereas it was in 1832. His application for a patent in America was made in 1837; his French patent was dated 1838, and a subsequent patent taken out in America was dated 1840; and the first telegraph line was constructed by Mr. Morse in 1841. As an old associate of that gentleman, he felt it his duty to make these corrections of dates relative to his inventions in telegraphy. With regard to the North Atlantic route, in which he (Colonel Shaffner) took great interest, it was stated in the paper that no results were obtained by the surveys of the *Bulldog* and the *Fox*, in the year 1860. In that year Sir Leopold McClintock surveyed the route between Scotland and the Faroe Islands, and thence to Iceland, Greenland, and Labrador; and the result was, that Sir E. Belcher and others were of opinion that it was a practical route for a line of telegraph to be carried, and so favourably had it been regarded, that he was informed by friends who had the enterprise in charge, that they had one-fourth of the capital in hand for the construction of a cable to be carried by that route. They offered no opposition to any other route. In the early days of telegraphy he was of opinion that monopoly in such matters was beneficial, but he was of a different opinion now. He should be delighted to see all the projects for telegraph communication with America carried out, and if they were accomplished, he believed all would be benefited, and the public would be better served. He wished success to them all.

Captain SELWYN, R.N., said he believed he was known to some of the telegraphists present, as having proposed a different mode of submerging cables to that which had been generally adopted, but he would not refer to this, but would confine his observations to the matters treated of in the paper, and whilst he expressed his admiration of the comprehensive and extremely careful manner in which Mr. Masey had furnished them with the history of what had been done up to this time, there were some points in that history to which he entirely demurred. First, as regards the assumed new incline shown by Mr. Hoskins's soundings in the *Porcupine*, Captain Dayman's, although

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they were a considerable distance apart, resulted in laying down a line from Ireland into deep water, across the Atlantic, which, so far from being precipitous, had a descent of only 1 in 16, whilst the greatest descent which was found by the *Porcupine* was 1 in 19, neither of which gradients he thought was to be feared in the laying down of a cable. Mr. Masey had ably remarked upon the probable cause which led to the failure of the Atlantic cable, and had fairly expressed his opinion as to how that might have been expected to have taken place, but he begged to add to those remarks that in that failure, evidence was afforded that the outer wires to which they trusted for strength failed in their object, and permitted the internal core to become separated. He was the more induced to refer to this point, because he found that there was still a disposition to adhere to the mechanical fallacy of surrounding a straight core with a spiral covering, and then expecting the covering to take the strain, which, of course, it could not do. If they could prevent corrosion from the water and abrasion from the bed of the ocean, by the interposition of other material than iron, he questioned whether the wire covering answered any good purpose, as it was known that iron wire corroded more rapidly in salt water than any other insulator, and, therefore, alone, cables of that character required a covering of hemp, or other material. Then came the question, with a cable of that bulk and weight, what description of ship must be employed to pay it out. The *Great Eastern* herself could not take such a cable on board; and if she could, he utterly denied that by her, as Mr. Masey had asserted, pitching and rolling had been done away with, or their evil consequences to a cable during the paying out in the least degree obviated. The *Agamemnon* could only carry a portion of the last Atlantic cable in her hold, and was obliged to carry a heavy deck coil; and he was told by an officer who accompanied the expedition that, if it had been possible, they would, at one time, have hove that part of the cable overboard to ease the ship. He thought, although the failure of the cable was, in great measure, attributable to the coiling, it was also due to the want of strength in its construction. In determining the route along which a cable should be laid, one great consideration was to provide for the landing of the ends in positions where they were not exposed to the fouling of anchors, and with that view a locality should be sought for where there was such a depth of water as would avoid such a risk. The shore ends would always remain a difficulty so long as they selected sandy bays or shoals for the landing. If they wished to preserve the cable from the injuries to which it was generally exposed at the ends, they ought never to take it where there was less than 100 fathoms of water, and the more precipitous the shore was the safer it would be, even to the extent of carrying the cable up the face of a steep rock. There was one route which he thought worthy of consideration which had not been mentioned. About 300 miles to the westward of the great bank of Newfoundland, another bank existed called the "Flemish Cap." The Grand Bank was to be avoided because the fishing smacks anchored upon it. At the locality he referred to they might lay the cable in from 50 to 100 or 200 fathoms, and it was quite practicable to lay it in that depth of water, and to pick it up again if necessary; from thence they might run it to the more distant shore, whether at Halifax or elsewhere. He denied those conclusions which pointed to the idea that nautical men could carry on any operations at sea otherwise than by the mercy of Divine Providence, for no human contrivance could carry a cable across the ocean in the face of the elements. Captain Selwyn having described the effects which the pitching of a vessel in a gale had upon the paying out of a cable in the production of kinks, which occasioned so much damage to the cable, concluded by remarking that by the plan he had introduced for coiling the cable, preparatory to its being laid, it could be kept in water from the time of its manufacture until it was laid down; and in the paying out, by another invention of his, if the cable broke within six miles of the stern of the vessel it could be caught and retained. Mr. Masey had sought to explain the absence of any nautical authority from the consulting committee of the Atlantic Company in a way highly complimentary no doubt to the service of which he (Captain Selwyn) had the honour to be a member. But as no such difficulty had apparently been found to exist in the case of engineers, he, for one, could not accept the compliment at the expense of another profession. In the event of a nautical assessor being appointed on any future committee upon this subject, he hoped to have the honour of explaining his invention to that gentleman, and to have the opportunity of substantiating opinions which had received the sanction of many of the most eminent members of his profession, some of whom had had large experience in the laying down of cables.

Mr. MACKINTOSH had listened with great pleasure to the interesting discussion which had taken place that evening on the subject of submarine telegraphy, but the speakers had omitted to notice one of the most vital points of the whole matter, that was, how long perfect insulation could be maintained in long lines of submarine cables. It was a well-known fact that both gutta percha and india rubber were absorbents of water to the extent of 20 or 25 per cent., but in large conductors with considerable insulation, they would remain practically useful for some time, though afterwards they gave way; and therefore, with reference to the maintaining of these long deep-sea cables without some better protection than had yet been given to them, he thought there was no chance of a successful result. The opinion of those best acquainted with the subject, was that the question of insulation, as applied to long lines of submarine cables, was very far from having received a satisfactory solution. It was very well where they had large conductors and short working stations, but when they came to lines of between 2,000 and 3,000 miles, unless they protected the gutta percha insulator with an impervious material, he believed it would be impossible to succeed with long lengths of submarine cables. With reference to the destructibility of cables from marine insects, it was a well-known fact that they had a great antipathy to carbon. In preparing an outside covering, he believed india rubber, mixed with large quantities of carbon, was the most practical and economical preservative, and the strands of wire might be embedded in that material. He thought that as an insulator, collodion was well worth a trial, and he would suggest that an experiment with wire of No. 16 gauge, covered in one case with gutta percha, and in another with india rubber, and in a third with collodion, should be laid, he believed the result would be found to be that, under a pressure of two or three tons both the gutta percha and the india rubber would lose their insulation, whilst the collodion would remain as compact as a piece of glass.

Mr. CROMWELL VARLEY said that at the late hour to which the proceedings had extended, he could not touch upon many of the topics which had been introduced in this paper, and in the discussion, but which were contrary to fact. With regard to the influence of the aurora borealis on the telegraph wires, he would state that in the distance from London to Ipswich, only 70 miles, he had often measured the tension of the currents flowing through the wires, and on two occasions he found it equal to 150 cells of Daniell's battery. This phenomenon was observed alike in submarine cables, subterranean, and aërial wires. During aurora displays there were invariably currents passing through the surface of the earth itself; the wires being good conductors of electricity conducted a large portion of the terrific electric flood traversing the earth. He had been in frequent communication with the Astronomer Royal, and it was invariably found that when these currents were seen upon the wires the magnetometers at Greenwich were greatly disturbed. Latterly these wire disturbances had been communicated to Admiral Fitzroy, to assist him in his forecasts of the weather. Mr. Varley having observed that changes of weather frequently followed these electric displays, communicated with Admiral Fitzroy on the subject, to whom the wire disturbances are now regularly communicated. Admiral Fitzroy has discovered that these wire disturbances, or earth currents, frequently indicate a change of the weather three or more days before it is felt on the surface of the earth. The next point he alluded to was the specimen of cable before them; this was not what was proposed for the the Atlantic line; it was a specimen of the shore end of the projected Persian Gulf Cable. The dimensions and construction of the Atlantic cable were not yet settled. It was obvious that no ship in existence, the *Great Eastern* not excepted, could carry so great a weight as 2,000 miles of cable, similar to the specimen shown. Much had been said about the action of marine insects. The Toulon and Algiers cable, which was covered with steel wires, each of which latter had been previously covered with tarred yarn, was found on being raised from a depth of 1,600 fathoms, to have been attacked; the yarn and tar had been eaten into, but the gutta percha was not injured, nor did he think there was any reason to fear injury, seeing that other cables laid in this same sea, viz:—the Spezzia Corsica cable, the Corsica and Sardinia cable, the Malta and Alexandria cable, and others, some of which had been eight years under the sea, were still in perfect working order. He had been very frequently engaged repairing submarine cables, chiefly in the North Sea and the St. George's Channel. In no instance had he ever found any indication of the cable being attacked by marine insects. The specimens from the Mediterranean were the only ones in which he had observed them. A great deal had been said about the effects of the pitching of vessels in rough seas. Man cannot at present control the weather, and unless engineers are prepared to lay their cables in a gale of wind, as well as in smooth water, it would be useless to attempt the operation on a long line. The first cable laid between

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England and Holland was laid in a very heavy gale of wind. During the process of laying a cable the resistance of the water is so great that even in the mid-Atlantic the cable made but a very small angle with the horizon during the operation of paying out. This was a very important fact, because the lifting of the vessel did not bring so much strain upon the cable as would be the case if it hung perpendicular from the stern. Since the laying of the Atlantic cable great improvements had been made in the paying-out machinery. Messrs. Glass and Elliot had paid special attention to this subject; they had self-acting friction gear so constructed that when any strain came upon the cable from any cause, it yielded and more cable ran out; the consequence was that, during the paying out of a cable at each lift of the stern, more cable went out than when the vessel was descending. The cable between England and Holland was laid last year with such machinery. He had no hesitation in saying that there was not a single kink in the whole of that cable. He quite agreed in the desirability of further surveys being made across the Atlantic, not only as regarded the direct routes, but all routes. The only inference to be drawn from the soundings made up to the present time was that the bottom of the Atlantic was covered with the softest ooze, and if exposed to view would, in all probability, be as flat and smooth as the great prairies of Illinois. In no one instance had the lead brought up anything but the softest ooze, excepting, of course, in the shallow water near the shores. One gentleman had suggested that a cable to America should contain several distinct conductors; this Mr. Varley pointed out could not be put into execution because the effects of magneto-electric induction from wire to wire was such that in an Atlantic cable it would be impossible to work more than one wire at a time. As the line was lengthened the working currents became weakened, but the induced currents increased; and from measurements that he had made upon the Dunwich Zandvoort cable it would be utterly impossible to work an Atlantic cable containing more than one conductor. He wished to state an important fact which ought to be borne in mind, viz.:—had it not been for Professor Thomson's elegant little reflecting galvanometer, the Atlantic cable would never have spoken at all. This galvanometer had but seventy yards of wire upon it. Reference had been made to a proposed telegraph without wires, a system recently patented by Mr. Haworth, as the latter gentleman had informed him that Sir Fitzroy Kelly, as well as the learned Chairman, had both seen it in operation and were connected with him, he should be glad if the Chairman would favour the meeting with an explanation of that system. He, Mr. Varley, being informed that the learned Chairman was a believer in the success of this scheme, had tried the experiment upon a very small scale in his own garden. The apparatus he constructed under the direction of Mr. Haworth; his two stations were only eight yards apart, and although he employed a reflecting galvanometer of the most sensitive kind, and twelve cells of Groves' nitric acid battery, he could not get any signals, although the experiments were varied in every conceivable way, and each part of the apparatus separately tested. He would have been very much surprised if he had got any signal, as it was contrary to the well-known electric laws.

Mr. THOS. WEBSTER, F.R.S., rose to suggest the propriety of the adjournment of this discussion till the following meeting. He remarked that a subject of this vast importance, involving so many questions of interest, could not be properly discussed in the brief time which remained after the reading of the paper. Although this subject has been discussed before several of the scientific societies, yet this Society, from its constitution, afforded the widest scope for doing so in a manner which its great interests and importance called for.

The CHAIRMAN said he was informed that arrangements had been already announced for future papers for several succeeding nights of the Society's meetings. Therefore all they could do would be to request the Council to fix upon as early an evening as possible for the renewal of this subject.

Mr. J. H. MURCHISON said, as one of the oldest members of the Society, he recollected occasions on which the discussion of subjects of less public importance than this had been adjourned to a future evening, and he would strongly support the suggestion of Mr. Webster that the same course should be adopted on the present occasion.

After a few further observations from Mr. Webster,

The CHAIRMAN said he had no doubt arangements would be made to afford an opportunity for a further discussion of this subject. With reference to what had fallen from Mr. Varley, he begged to say that he had seen no experiments whatever with the system of telegraphs without wires, and had never expressed any opinion upon it. He had given his advice with reference to legal matters, but had never expressed any opinion relative to the merits of the invention, one way or the other. He now begged to propose that the best thanks of the meeting be given to Mr. Masey for his paper.

The vote of thanks having been passed,

The Secretary announced that on Wednesday evening next, the 4th February, a paper by Mr. Alexander Burrell, "On Cooking Depôts for the Working Classes, recently established in Glasgow and Manchester," would be read.

The Secretary has received the following letter:—

Sir,—During the discussion last evening several speakers made allusion to hemp. It is worthy of note in these proceedings that the pressure of the sea at great depths destroys the fibre; and it will be found in Scoresby's remarks that whale lines which had been (some hours only) at bottom attached to harpoons in the whale were rendered useless; that wood of various densities, as well as cork, had all their vessels disrupted and would not float when they had undergone the pressure of 1,000 fathoms. It is well known that port wine, however well corked and covered with bladder and resin, is changed at 500 fathoms, and the bottle, with cork inverted, comes to the surface simply containing salt water. The pressure on the gutta percha of the cable would press home and expel all air; but unless again brought to the surface, no air could escape under the condensed condition of the gutta percha. We should therefore receive with caution all assertions as to the condition of cables recovered from great depths, the bringing to the surface having played the second part, as in condensing and exhausting. Yours, &c.,

E. BELCHER.

REPORT OF THE DIRECTORS OF THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

THE Directors are happy to be enabled to report the continued prosperity of the undertaking.

Notwithstanding the numerous reductions in rates which have been made during the last twelve months, the buoyancy of the revenue continues unimpaired. The extension of the Company's system in England—the expansion of the traffic with the continent—the recent opening of direct communication with the south of Ireland, thereby securing a proportion of the American business,—and the temporary stimulus of the International Exhibition, have combined to improve the receipts, and omitting the exceptional traffic, promise a continued development of business. On the circuits only between London, Liverpool, Manchester, and Birmingham, where the unremunerative charges still continue, is the traffic unproductive.

From the accounts it will be seen that the revenue of the half-year amounts to £117,074, which exceeds by £6,009 that of the corresponding period of 1861.

The great accession of work from extended area and reduced rates necessitates a continually increasing expenditure in staff, stationary, and other incidental costs. The entire working expenses consequently exceed those of the last half of 1861 by £4,007.

The Directors have further charged to the debit of revenue a sum of £4,000 towards the cost of additional wires from London to Liverpool and Manchester, rendered necessary by the increasing business. This expenditure in no way represents renewals, but is a clear enlargement of the Company's property. According to ordinary rules, therefore, it should be charged to capital, but under existing circumstances the Board have considered it sounder policy to debit the revenue with this amount, and they feel satisfied the Proprietors will concur with them in the wisdom of this course.

The net balance for disposal, after making this provision, is £36,127, out of which the Directors recommend a dividend of £3 10s. per cent. for the half-year. As the whole of the capital represented by the recently consolidated shares now, for the first time, participates in dividend, the amount required for this purpose is £31,075, leaving a surplus of £5,052.

The total expenditure on the new Zandvoort cable amounts to £57,449. Of this sum, £52,838 has already been provided out of the revenue of successive half-years. The surplus from last half-year will extinguish the debt, and leave £440 to be carried to the trust fund.

The state of the cables and the general condition of the whole property is in every respect satisfactory.

The communication between London, Cork, and Queenstown was opened on the 29th of September. At the last meeting the proprietors approved of the purchase of the unfinished works of the South of Ireland Telegraph Company, and an opening subsequently presented itself to acquire the cable of the London and Queenstown Direct Company on moderate terms. The Directors did not hesitate to avail themselves of this opportunity, and they have reason to be satisfied that the operation will be greatly for the Company's interest.

The increasing demand on the part of the public and the railway

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companies for telegraphic facilities rendered it prudent in the opinion of the Directors to provide in time for any future requirements, by a further issue of the capital authorized by the proprietors in October, 1857.

By the lamented death of Mr. William Dunlop, a vacancy occurred in the Board, and the Directors have filled it up by the election of the Right Hon. Sir John Lawrence, Bart.

The following Directors retire by rotation at the present meeting, and being eligible, offer themselves for re-election, viz. :—The Hon. R. Grimston, Mr. Brassey, Mr. J. Hawkshaw, Mr. E. R. Langworthy, and Mr. F. Micklethwait.

One of the auditors, Mr. Sim, has signified his wish to retire, in consequence of his duties interfering too much with his time; and it will rest with the Shareholders to nominate his successor.

Robert Grimston, *Chairman.*

February, 1863.

Electrician's Report.

Gentlemen,—It is with much pleasure that I have to inform you that your main circuits are in very good order; we never were so little interfered with by the effects of rain or fog as at the present time: this improvement has contributed largely to enable us to meet the heavy pressure of work during the past half-year.

During the last few months unusually violent gales have prevailed. Telegraphs generally, in this country and on the continent, have suffered interruptions of a serious character; but comparing the damage done to your poles with our previous experience, we have suffered to a trifling extent.

The severe trial that your system has undergone proves that it has been efficiently maintained.

The new cable between Lowestoft and Zandvoort was laid on the 14th August. Owing to the improved manufacture of gutta percha, these wires test eleven times better than those of the Dunwich Zandvoort cable. The fourth wire of the latter, which had been defective for a period of two years, was successfully repaired on the 4th October. All wires test remarkably well, and their insulation is as high as when first submerged. During the gales of the 17th and 18th October this cable was broken by a ship's anchor about five miles from the English shore; this break was repaired on the 30th of the same month. It is worthy of note that this heavy cable has never been broken at a greater distance from the English shore than nine miles.

The Holyhead and Dublin cable was chafed through by a rock, on the 9th of November, 1862, and repaired again on the 19th of the same month.

Additional cables have been laid across the Frith of Forth and river Tay, some of the wires of the existing cables having become defective.

The whole of your wires between London and the South of Ireland are working very satisfactorily, and we have no difficulty in the worst weather in communicating direct between this station and Roches Point, a distance of 520 miles, including 68 miles of submarine cable.

The following works have been completed :—

An additional direct wire between London and Cardiff; the erection of the telegraph on the Vale of Clwyd Railway; on the Whitehaven, Cleator, and Egremont Railway; on the Morecambe branch of the Midland Railway; on the Bedford branch of the London and North Western Railway; and other minor lines.

Your wires have also been extended to a new office in the Derby Corn Exchange, and also to Clifton, near Bristol, and, since the commencement of the present year, to the centre of the town of Leicester.

The following works are in the course of construction :—

The telegraph on the Bedford and Cambridge Railway; on the Cockermouth, Keswick, and Penrith Railway; the extension to the towns of Stockton-on-Tees and Middlesboro'.

The new wires to Liverpool, Manchester, Hull, Edinburgh, York, and Southampton, are progressing rapidly, as also the new wires between Wexford and Dublin.

Your present mileage is as follows :—

Miles of line	7,597
Miles of wire...	35,066
Number of instruments	4,003

Cromwell F. Varley, *Electrician.*

The balance sheet attached to the Report is deferred until next week.

The half-yearly meeting of the shareholders of this company was held on Tuesday at the offices, Telegraph Street; the Hon. Robert Grimston in the chair.

The Chairman, in moving that the report be adopted, said he had much pleasure in laying the balance-sheet before the shareholders, as it showed an increase of £6,000 in their revenue. During the four earlier months of the half-year the increase had been considerable; but during the last two months of that period it had not been so large, which might be accounted for by the fact of an early winter on the continent. But, as he had already observed, the receipts showed an increase of £6,000 above those for the corresponding period of 1861. Knowing how much the business of the office depended on the general trade of the country, and with the cotton famine staring them in the face, he for one had certainly expected that trade would have been now in a state of collapse, and that the company's receipts would have thereby suffered. Such, however, happily had not been the case. On the contrary, they had gone on increasing, and it ought to be borne in mind that these receipts had been earned with a tariff which had been reduced to 200 places. It had been reduced to Glasgow one-fourth, to Edinburgh one-fourth, to Bristol one-third, and so on to all the most important places in the kingdom. The result of those reductions had been precisely what the directors had anticipated, the messages had increased, but the revenue, which had been abandoned, had not as yet been replaced, but ultimately such would be the case. However, with an increase in the continental traffic, at those stations where the tariff had not been reduced, and at various new stations, the directors were enabled to come before their constituents with a revenue, not only not diminished, but increased to the extent he had mentioned. The expenses of the half-year were far greater than the previous half-year, for an increase in the number of messages meant an increase of working expenses in wages to instrument clerks and messengers. In the accounts before them the shareholders had those facts illustrated as clear as figures could make them. The wages of the instrument clerks amounted to £2,763, and the cost of porterage to £4,273, as against £3,793 reported this time last year. There was also an increase in the cost of stationery. All those were the cost of the concessions they had made to the public. They did not regret having taken that step, as it was, he believed, a wise one, and not adopted until after it had been fully deliberated upon, and it would, he hoped, be the means of placing the business of the company on a broad and sound basis. When, however, he said the reduced tariff would gradually right itself, he meant a tariff moderately and judiciously reduced, not one recklessly reduced. The shilling charge for twenty words from London to Liverpool, and from London to Manchester, could never pay. Their wires were full of work between those stations, and yet every message was carried at a loss. There was, however, for the present, no help for it, inasmuch as it was forced on the company, for if they were to tell their customers that they could not do the work for them at that charge, they would take their custom elsewhere. As it would be impolitic to raise additional capital to work a traffic which was not remunerative, the cost of the additional wires which were required for it was looked upon in the light of maintenance, and charged to revenue. They had added £5,051 to the trust fund, which was, he considered, the sheet-anchor of the company, and had made arrangements for sending uninterrupted messages to Berlin, and other important places on the continent; and in the event of there being a new transatlantic cable laid down, the Electric and International Company would have the only line of telegraph between London and the south-west of Ireland, as they had entered into working arrangements with the London and Queenstown Company, and a message from London to Cork now occupied three minutes. He had to express the regret of the Board at the death of their late colleague, Mr. Dunlop, and at the retirement of their auditor, Mr. Alexander Sim.

Captain Huish seconded the motion, which was unanimously adopted.

The outgoing directors were re-elected. Mr. Pressley was elected an auditor in succession to Mr. Sim; the annual remuneration of each auditor was fixed at £100.

On the motion of Mr. Nolls, the thanks of the company were voted to Mr. Sim for his past services; and that gentleman having replied, The proceedings were brought to a close in the usual manner.

M. Fremy, the distinguished French chemist, lately read before the Academy of Sciences a communication from Messrs. Calvert and Johnson, of London, stating as the result of their observations that *pure* lead is more readily acted upon by sulphuric acid than are most of the impure varieties of the metal. The explanation of this fact would doubtless be of interest from the point of view of voltaic science; as it is well known that zinc especially, and other metals, are acted upon by acids much more rapidly when very impure than when chemically purified. We may hazard the opinion that the metal iron, constantly associated with lead as an impurity, exerts a protective influence upon the latter metal; iron being higher than lead in the scale of electro-positive bodies.

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UNIVERSAL PRIVATE TELEGRAPH COMPANY.

In submitting the annexed balance sheet of this company's operations to the 31st August last, drawn up and certified by the official auditors (Messrs. Alison and Waddell, public accountants), it is necessary to call attention to the fact that the system of private telegraphs at the date of the formation of this company was entirely new, and its introduction has therefore been attended with many difficulties and expenses which in future operations will be avoided. The company have now established their system in the metropolis, of which a considerable area is traversed by their lines. In Glasgow lines have been established with marked success, extending as far as Greenock, Paisley, Barrhead, Busby, Campsie, and the Vale of the Leven, between twenty and thirty miles distant. Operations are also proposed in Dundee and Edinburgh.

The company have recently, in co-operation with gentlemen of great influence at Manchester, commenced the development of an extended system in and around that city, to include Preston, Bolton, Wigan, Blackburn, Rochdale, Burnley, Bacup, Glossop, Hyde, Stockport, and the whole of the manufacturing districts where the advantage of a private communication between offices and works is highly appreciated and can be made remunerative, and where, no doubt, the necessary capital will be provided. A portion of these circuits will shortly be opened.

In Liverpool, Birmingham, Newcastle, and on the banks of the Tyne, extensive works are also proposed whenever the necessary capital is subscribed, which will prove highly remunerative to the company.

The success attending the operations so far, and the estimation in which the system is held by those adopting it, are such that there is no doubt that a large and increasing business will yearly advance the commercial prosperity of the company. The difficulty of introducing long circuits have been overcome, and the future extension of the lines may be regarded as based upon the most perfect system at present available.

The management of the company's business throughout the kingdom has been entrusted to influential local committees, who will each superintend the efficient working of their respective districts under the general control of the Board of Directors. During the present year it is proposed, by an increase of the subscribed capital, to complete the system already commenced in the districts mentioned. The financial result of the company's operations, as exhibited in the annexed general balance sheet to 31st August last, shows a net revenue over expenditure sufficient to enable a dividend of five per cent. to be declared, while the prospects held out on the completion of the lines are such as lead to the conclusion that larger profits will be derived hereafter.

The first directors named in the company's Act have found it greatly conducive to the interests of the company to enlarge the board, and a list of the present directors prefaces this report.

By resolution of a special board, held 23rd January, 1863, the whole board retire and offer themselves for re-election.

CAPITAL ACCOUNT

From the formation of the Company, 17th Sept., 1860, to 31st Aug., 1862.

Dr. EXPENDITURE.	£	s.	d.	RECEIPTS.	£	s.	d. *Cr.*
To Material and Erection of Wires	15,267	11	5	By Share Capital:— 1st, 2nd, and 3rd Calls, £15 per Share (*see contra**)	21,890	0	0
Instruments and Fittings	6,158	3	1	4th Call (in course of payment) received on account to 31st Aug. ...	6,050	0	0
Furniture and Fittings ...	199	2	7	Advance of Calls	5,225	0	0
Concession of Wheatstone's Patents, in Shares,* of which £10,000 take no Dividend till £60,000 are subscribed	17,000	0	0	Balance (See General Balance Sheet)	5,459	17	1
	£38,624	17	1		£38,624	17	1

REVENUE ACCOUNT.

To Line Expenses and Maintenance	450	15	2	By Wires and Instruments	2,469	2	7
Salaries, Rent, and Office Expenses	559	15	0				
Balance carried down ...	1,458	12	5				
	£2,469	2	7		£2,469	2	7
To Interest on Calls in advance	102	4	2	By Balance brought down ...	1,458	12	5
Maintenance Fund (reserved on Engineer's Estimate)	339	2	0				
Balance (See General Balance Sheet) ...	1,017	6	3				
	£1,458	12	5		£1,458	12	5

GENERAL BALANCE SHEET.

ASSETS.				LIABILITIES.			
To Bankers' Current Acct.	739	15	5	By Creditors ...	6,066	13	3
Cash in hands of Officers ...	202	16	10	Bankers (Loan) ...	2,000	0	0
Rentals in course of payment ...	478	14	6		8,066	13	3
	1,421	6	9	Maintenance Fund, reserved from Revenue	339	2	0
Preliminary Expenses (including Act of Parliament)	2,541	17	8	Revenue Account:— Balance of profits as above	1,017	6	3
Capital Account: Balance as above	5,459	17	1				
	£9,423	1	6		£9,423	1	6

Signed by the Auditors,
ALISON AND WADDELL,
Public Accountants.

REPORT OF THE DIRECTORS OF THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.

THE annexed balance sheet contains a statement of the Company's transactions for the half-year ending on the 31st December, 1862, which the directors believe will be considered by the shareholders as very satisfactory.

The receipts have materially increased, whilst the expenditure has been diminished.

The company's cables continue in excellent working order.

The directors have learned with much pleasure that the cable between Marsala, in Sicily, and Cape Carbonara, in Sardinia (alluded to in their last report as being about to be laid by the Italian Government), has recently been successfully submerged. They have looked forward to this event as one of the means of ensuring a more rapid, and, what is of equal importance, a more regular transmission of messages between India and this country. The cable will shortly be in working order, and the directors hope to announce at the August meeting that their anticipations in this direction have been realised.

The usual payment of the dividend on the preference shares, and the payment of a dividend on the original shares are recommended.

In their last report the directors suggested the expediency of establishing out of the profits a reserve fund to meet contingencies. They think that the time has now arrived when that suggestion should be carried into effect; and they therefore recommend that at the approaching meeting a sum should be set apart and invested as the commencement of such reserve fund.

HENRY MOOR, *Chairman.*
HENRY C. ORTON, *Secretary.*

January 23rd, 1863.

Balance Sheet of the Company for the Half-year to 31st December, 1862.

Dr.	£	s.	d.	*Cr.*	£	s.	d.
Balance of Capital Account (as shown below)	302	6	11	ASSETS.			
LIABILITIES.				Amount due from other Lines on account of Messages transmitted by the Company to 31st December, 1862	16,451	1	5
Deposit on Account of Messages to be transmitted	214	17	4	Sundry amounts due to the Company for Messages transmitted	118	1	2
Amount due on account of Messages transmitted over other Lines, to the end of February, 1861, 2,910 7 10½				Amount due from H. M. Government, as per Dividend Account	286	2	6
Ditto to 31st December, 1862, 11,639 18 11				Bills Receivable	125	0	0
	14,550	6	0½	Cash at Bankers'	1,767	16	2
Bills Payable	25	16	0	,, in hands of Officers of the Company	220	2	7
Sundry other amounts owing by the Company	179	2	2				
Surplus Balance of Dividend Account	3,695	14	7½				
	£18,968	3	10		£18,968	3	10

CAPITAL ACCOUNT.—(*Original Line.*)

Cost of Construction and Preliminary Expenses	117,984	19	5	Amount received for issue of 12,000 shares of £10 per Share	120,000	0	0
Unexpended Balance transferred to the Capital Account of the Corfu and Otranto Line	2,503	19	1	Forfeited Deposits and Interest on Investments	488	18	6
	£120,488	18	6		£120,488	18	6

CAPITAL ACCOUNT.—(*Malta and Sicily Line.*)

Preliminary Expenses	397	14	0	Amount received for issue of 1,500 Preference Shares at £10 per Share	15,000	0	0
Amount of Contract for Cable	12,100	0	0				
Unexpended Balance transferred to the Capital Account of the Corfu and Otranto Line	2,502	6	0				
	£15,000	0	0		£16,000	0	0

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Capital Account.—(*Corfu and Otranto Line.*)

Preliminary Expenses		252 5 10	Unexpended Balance of the Capital Account of the Original Line	2,503 19 1		
Amount expended on construction of the Land Line...		521 12 4	Ditto of the Malta and Sicily Line	2,502 6 0		
Amount of Contract for the Submarine Cable.....		20,030 0 0			5,006 5 1	
Balance		302 6 11	Amount received for issue of 1,700 Preference Shares at £10 per Share		17,000 0 0	
	£22,006 5 1				£22,006 5 1	

Dividend Account.

Amount of Dividend on Preference and original Shares, paid and brought to Account in the half-year to 31st December, 1862		3,631 12 3	Surplus Balance 30th June, 1862, as per last Balance Sheet		3,556 3 10½	
Income Tax on Dividends ...		138 0 0	Surplus Balance of Revenue Account to 31st December, 1862		3,313 17 6	
Surplus Balance		3,695 14 7½	Amount realized by the Sale of Old Stores		309 3 0	
			Amount due from H.M. Treasury under the Guarantee ...	3,600 0 0		
			Less excess of Revenue above the working expenses for the half-year to 31st December, 1862	3,313 17 6		
					286 2 6	
	£7,465 6 10½				£7,465 6 10½	

Revenue Account.

Expenses of the Offices, Stations, and Agencies in London, Malta, Corfu, Naples, &c., including Directors' Fees, viz.:—			Net Receipts for Messages in the half-year to 31st Dec., 1862		5,100 6 1	
Salaries, Wages, and Agencies ...	1,444 0 5		Interest on amount deposited with Messrs. Overend and Gurney		6 4 2	
Rent, Fuel, and Light ...	161 3 10					
Miscellaneous and Petty Expenses ...	340 3 5					
Maintenance of the Lines.	108 11 1					
	£2,053 18 9					
Deduct Alexandrian Lessee's proportion of the Malta Office Expenses for half-year to 31st December, 1862	262 4 1					
		1,791 14 8				
Message Charges Refunded ...		0 18 1				
		£1,792 12 9				
Surplus Balance carried to Dividend Account		3,313 17 6				
		£5,106 10 3			£5,106 10 3	

Examined,

Treasury, *22nd January*, 1863. R. MILLS.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—As in electricity, so in chemistry, our greatest men not unfrequently commit themselves to crotchets and puerile errors. In reading Dumas it is impossible to feel other than in the presence of a great genius; but, while greatly admiring the man, I was induced, in 1854, to write a severe criticism of his chemical philosophy, as evinced in a memoir which fascinated Faraday, and delighted the British Association of that year.

I did not publish the article, chiefly because I am a humble worker in the very background of philosophy, with qualifications inadequate to appear in such brilliant company, and partly because that accomplished leader soon gratified me by a recantation of the chemical errors which I so unmercifully exploded.

My interest is renewed by your article in this week's number on "Thallium," in which Dumas still clings to some of the worst features of his original paper.

As the advocate of old electro-chemistry, I would not *wholly* repudiate the numerical vagaries which have so much misled modern chemists; but I do contend for plain common sense in their careful study and appreciation; they may or may not contain some tittle of chemical truth.

By the light of figures, Dumas assigns to thallium the most conspicuous position in the alkaline group.

That this is greatly in error, I feel quite confident, and even deny its position at all in that series.

Dumas says:—"It is no exaggeration to say, that, in regard to the classification generally accepted for the metals, thallium offers an assemblage of contradictory properties which entitles it to the name of a metallic paradox, the ornithorincus of metals."

The ornithorincus is now no paradox in Natural History, and so I predict of thallium, that it will occupy a clear and definite position with no affinities whatever to the alkaline metals.

If it would not be intruding too much on your space, my criticism of 1854 is quite at your service for publication. And, deeming it even very desirable to reduce learned points to the level of a popular apprehension,—I beg to remain, yours, &c. Samuel E. Phillips.

To the Editor of The Electrician.

Sir,—I have been much interested in your articles on "Secondary Batteries," especially in the one described by M. G. Plante, and also the one refered to by you, where you have replaced the sheet lead by zinc with better results. What I wish to ascertain is, whether these secondary batteries give *quantity* as well as *intensity?* and, if so, the correct manner of constructing one. If I construct one with several rolls of zinc and canvas, should they each be placed in a separate jar with acid solution? and should they all be connected by the zinc to each other, or from the zinc to the solution of acid of each jar? And in connecting the primary battery, should one pole be in connection with the zinc and the other to the solution, or both poles connected to the zinc? In a secondary battery of this description, is the current momentary, or does it last any time?

In speaking of the battery constructed with sodium, can you inform me how many elements I should require to work an induction coil containing over two miles of secondary wire and fifty-four yards of primary wire in three layers, length of iron core twelve inches? This coil has about thirty layers of secondary wire, and, with five Bunsen's elements, zinc immersed seven inches by three, does not give, either at the primary or secondary wire, so large a spark as when there was only fourteen layers of secondary wire, with *one small Bunsen element* The condenser is formed of thirty-six sheets of tin foil, eight inches by six, and does not increase or decrease the secondary spark; a small charge seems to be accumulated by it, but not sufficient to the increase the power. I have arranged the five elements for intensity, and likewise for quantity, but the latter seems to give the best results of the two arrangements. If you can enlighten me on any of these perplexing difficulties, I shall feel much indebted to you.—Yours much obliged, J. Cook.

To the Editor of The Electrician.

Sir,—In your notice of the Minotto battery (Electrician, p. 143) you have quite correctly quoted the inventor's opinion, that increasing the resistance of a battery by placing its plates further apart is beneficial in working long lines of telegraph, because "the work of the battery is best utilized when the sum of its resistances approximates to the resistance of the line wire and instruments." Is not the law misconceived? and is it not more correctly stated thus?—

Given a certain fixed distance between the plates of a battery, a fixed strength of exciting liquids, and so many square feet of zinc and copper to be cut up into plates for working a line of telegraph.

The sheets will be most efficiently employed when they are cut up into so many pairs that the resistance of the battery so formed shall equal that of the rest of the circuit. That is, the plates should be cut smaller and the metal employed to fit up additional cells until the desired resistance is attained.

From what M. Minotto states, it would seem that if a certain series of cells were insufficient to work a given circuit, and if the resistance of the series were less than that of the line and instruments the simple addition of a thicker diaphragm to increase the battery resistance would be beneficial. This is certainly not correct in practice.—Yours. &c.,

R. S. Culley.

[We quite agree with Mr. Culley. Nothing can be gained by simply increasing the internal resistance of the electromotor; on the contrary, theory plainly indicates that the reduction of this resistance must always, to some extent, be attended with advantage. This is not the only point in which the statements advanced by M. Minotto are deserving of stricture.—Ed. E.]

To Correspondents.

K. R. U.—Your best plan, if you aim at obtaining higher tension, would be to add to the secondary coil the length of wire you propose to use as a tertiary coil; otherwise you could scarcely do more than increase the quantity of electricity set in motion.

L. E. F.—We believe that the Emperor of the French is at present engaged in the construction of an electro-magnetic engine, which, it is expected, will surpass anything of the kind which has hitherto been attempted—even the celebrated engine of Prof. Jacobi, by which a boat was propelled on the Neva.

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The Electrician.

VOL. III. No. 68.—FEBRUARY 20, 1863.

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ON THE LAWS OF THE VOLTAIC CIRCUIT.

IT was with full cognizance of the fact that we took into our own hands the discussion of certain points of electrical doctrine with our contributor Mr. LAMING, that we appended an editorial note to this gentleman's communication in our last issue. When, in a new theory, the signification of terms in common use and constant application is essentially altered, discussion must generally be unsatisfactorily devoted, in great measure, to the gradual elucidation of the true value attached by the disputants to certain expressions. Thus our correspondent, "London District," after propounding a question which necessarily, to his mind, involved a series of consequences adverse to Mr. LAMING's theory, must have been sorely puzzled when the question was answered in accordance with the results of his own practical experience; while, by a misconception of the value of the term resistance, in its common acceptation, the necessary consequences were brought into dispute. We are happy to perceive, however, that there is no necessity for any waste of argument upon uncertain and undefined premises. If we differ from Mr. LAMING in several of his views relating to voltaic phenomena, it is, forasmuch and inasmuch as he dissents from the universally accepted formula deduced by OHM from his masterly researches, and expressing the conditions which modify the quantity of electricity traversing a voltaic circuit. In this, the capability of the voltaic source to supply electricity is limited solely by the resistances, fluid and metallic, opposed to the electromotive force; the term resistance being taken to express simply the converse of conducting power. Hence with a battery of given electromotive force and internal resistance, the quantity of electricity traversing a wire of determinate resistance—whether of large or of small diameter, or compounded of both in any fashion we please, will be always the same. This quantity may be increased either by diminishing the internal resistance of the battery, or by increasing its electromotive force, and hence there is no "limit of conductivity" in a wire, although every wire possesses a determinate "resistance;" neither can a wire be occupied in "doing its maximum amount of conduction," according to Mr. LAMING's views, if the fundamental propositions of OHM be correct. And for their complete accordance with every experimental result that has been obtained we, and hundreds of our readers, can vouch from experience. The theoretical basis upon which they rest may possibly be perfected; but we confidently maintain that their practical accuracy cannot be impugned by experiment. Of this we are ready to advance any proof that may be required, notably that which is now demanded relative to the statement appended to Mr. LAMING's article in our last number.

It may be useful to quote here the fundamental formula to which we have referred, the correctness of which, we must observe, requires to be disproved before Mr. LAMING's views can receive acceptance. It is as follows: —

$$I = \frac{E}{R + r},$$

in which I signifies the intensity of the current, or the quantity of electricity traversing the circuit; E the electromotive force; R the internal (fluid) resistance of the battery; and r the external (wire) resistance.

R varies directly with the distance D between the voltaic elements, and inversely as the area of the section S of the exciting fluid; or

$$R = \frac{D}{S},$$

r varies directly with the length of wire, and inversely as the area of its section, or, what is the same thing, the square of its diameter,

$$r = \frac{l}{S}.$$

The verification of the statement advanced in our last number will perhaps be accepted by Mr. LAMING as an *experimentum crucis* upon the relative value of his theory and the above formula. In this case, we can see no difficulty in removing the grounds of difference between our contributor and ourselves in certain essential doctrines of voltaic electricity. Let Mr. LAMING take a wire, No. 16 gauge, having a resistance of one thousand units, and, after having determined its "conductivity," by ascertaining that the quantity of electricity traversing it with a battery of constant or negligable resistance, is directly proportionate to the electromotive force, let him add to each extremity a length of very fine wire, having a resistance of *one* unit only, he will certainly find that neither the "conduction," nor the "conductivity," under any circumstances, is thereby very appreciably affected. But, let him now measure the length of the wire, and substitute for it an equal length of another wire of the same diameter as the fine extremities. In this case the difference in "resistance," "conduction," and "conductivity," will be very perceptible indeed, and the increase in the first term will be simply proportionate to the decrease in the two latter. In regard to the problem of improving the conductivity of the circuit after attaching the small extremities of wire, we have merely to reduce the wire resistance from 1002 to something appreciably below 1000 units, which of course may be easily done by replacing a portion of the No. 16 gauge wire by an equal length of wire of larger diameter, say No. 6 gauge. We have not tried the experiment precisely in the form we now propose it; but, in the operation of "testing resistances," we have constantly obtained results analogous to those we now anticipate; and if we had any doubts as to the latter, we should at once have recourse to an experimental confirmation of our former observations.

It should be remembered that the practical formula of OHM which we have given is constantly employed in the ordinary operations of the electrical engineer and telegraphist, and that its perfect accuracy and usefulness as a guide to practice has been confirmed by the most extended experience. Nevertheless, for the hundredth time, it is now questioned on grounds of theory. We stated last week that Mr. LAMING's views *appeared* to be opposed to the result of experiment. The article by this gentleman in the present number removes any possible apprehension that after all a question of terms only might be involved, and that his views and the facts upon which the theory of OHM is based could possibly be reconciliable. The discussion, if continued, must now resolve itself into the investigation of the practical accuracy of the formula of OHM; a subject which cannot fail to benefit the inquirer, in furnishing a groundwork for future research which may be strengthened, but can never be shaken, by any new data of theory or practice.

To render muslins, calicoes, &c., blaze proof, they should be immersed in a solution of 1lb. tungstate of soda (costing about 1s.), to two gallons of water. The articles require to be saturated with the solution every time they are washed. If required to be starched, the salt may be added to the starch before mixture with water, in the proportion of 1lb. of the tunsgate to three parts of starch.

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CONDUCTIVITY AND RESISTANCE.

BY RICHARD LAMING. M.R.C.S.

(Continued from page 168.)

"HENCE a large conductor with small ends can act no better than another conductor small throughout its entire length."—EQUIVALENT THEORY OF ELECTRICITY, ELECTRICIAN, vol. 3, page 168.

"We are bound to express our dissent from this view. Whatever may be the nature of electrical conduction—whether simple or compound—the above assertion appears in obvious contradiction to experimental fact. We may attach 'small ends' of wire to the extremities of a telegraphic line, without perceptibly reducing the conductivity; and we may then, by increasing the diameter of the middle portion of the line wire, improve the conductivity beyond the degree indicated by the galvanometer or electro-magnet, previously to the fine wire being placed in the circuit."—ED. E.

It is said the doctrine "*appears* in obvious contradiction to experimental fact;" let us inquire whether appearances are not being misinterpreted. First, the Editor sees it to be a fact that "we may attach small ends of wire to the extremities of a telegraphic line without perceptibly reducing the *conductivity*." The word should have been *conduction*; for it is quite manifest that what is "*perceptibly* indicated by the galvanometer or electro-magnet" is, in all cases, the quantity of electricity actually conducted, and not in all cases the capacity to conduct, which, for anything these instruments can indicate, may in certain instances be only to a small extent called into operation; and if the proper word be substituted for the wrong one, the declaration may, in particular cases, be true without denying the doctrine which is objected to. I will illustrate this part of the subject by the analogy already applied to it, while I explain it physically on the principles of the theory.

The expression which truly describes the possible electrical fact may be thus paraphrased and applied to water. "We may attach small orifices to the extremities of a water pipe without perceptibly reducing the quantity of water conducted through it." But on what condition is this possible? On one only, that is, when the water is supplied in quantity so small that the pipe itself, *if no larger than the small orifices*, would suffice to conduct it. And this is absolutely a necessary condition in the case also of electricity and its conductor; with the one fluid as with the other, if a conductor—whether pipe or wire—be conveying a quantity fully commensurate with its conductivity, any reduction, either in outlet or inlet, must diminish the quantity passing.

If the conductivity of a telegraph line *as a whole* were not sensibly reduced by adding small ends to its terminations, as my theory teaches, we ought to be able to annex such ends with impunity, even when the main wire is fully occupied in doing its maximum amount of conduction; but of this possibility we have had no practical evidence; we probably never work our telegraph main lines up to their limit of conductivity.

It is clear, therefore, that under some circumstances we may attach small ends of wire to the extremities of a telegraph line without perceptibly reducing the effect upon the signalling instruments, and yet it be true that "a large conductor with small ends can act no better than another conductor small throughout its entire length." One of the two appearances, then, upon which the Editor is relying, has deceived him.

In the second place the Editor states, in contradiction of the doctrine he has dissented from, that, having attached small ends to the terminations of a telegraph line, "we may then, by increasing the middle portion of the line-wire, improve the conductivity," meaning, of course, the conductivity of the line as a whole. That this has been ascertained by observation is not said, nor can I find any experiments that bear out the statement; not even on the supposition that conduction is meant instead of conductivity; and I may be allowed to require their production, if there be any, in order to have the opportunity of investigating how far they also may have been deceived by appearances. I cannot receive it as a fact merely because it has been assumed for the construction of a mathematical theory.

It was once a curious question whether small wires were not more effective than large ones for telegraph main lines, and although it has been since answered in the negative, the answer has been jumped at more from an undefined conviction that it must be so, than from any observation of actual occurrence. It would not be difficult to show that the question might be answered either way with equal adherence to truth; but to do it *en passant* would extend this article to greater length than would be convenient.

The first step that must be taken if we would fully understand the construction of the electro-telegraph conductor in its generality, is to compute electrical conduction with a direct relation to time, as influenced by the two conditions of conductivity and resistance. The Ohmic fusion of the two things into one, even as a mathematical device, is inadequate for the purpose, and will be understood to be so by all who have obtained an insight into their distinct physical natures. I have taken pains to show what is the nature of resistance, and how, according to certain laws made necessary by the common principles of mechanical philosophy, and that are consistent with observation, it checks the velocity of electrical conduction in antagonism to a defined electrical motive tension that forces electricity along the conductor. With respect to conductivity I have pointed out that, in any given kind of common matter, it is the measure of its existing conducting power, varying simply as the sectional area, and as the square root of the existing intensity of electrical induction. I have stated, also, that conductivity is a property of bodies which is invested in their particles individually, and which each of them exercises free from all influence of any particles beyond; or, in other words, that conductivity is irrespective of the length of a conductor, none of its larger sections being able to confer their larger share of it to any of the other smaller sections.

It still remains for these two conditions of conduction to be calculated together, each in conformity to its own particular laws; and we shall obtain, whenever we do so, a sure guide in every application of the telegraph conductor to new enterprises. I have satisfied myself that in every possible case of electrical conduction the result thus to be obtained by calculation will be found in accordance with experimental observation: and during the researches I have made on this subject I was led to perceive that it is for want of this compounding together the quantities of electricity handed simultaneously onward by different conductivities, and the periods occupied by conduction under different amounts of resistance, that the Report of the Telegraph Committee and its Appendix, so abound with facts that are apparently in contradiction to one another. On the principles I am expounding they seem resolvable into order; but to unravel so many entangled truths would be a longer and more laborious task than to arrange systematically the electrical action implicated from first to last.

There is one fact which I will leave for consideration, believing that it cannot be deliberately contemplated without throwing light upon the present subject. Detaching from the idea of conductivity all former notions about its relation to resistance, or its modification by length of conductor, and assuming it, for the occasion, to remain unaltered by reason of a constant intensity of induction acting upon each particle in a sectional area of a cylindrical conductor; then its total amount will be simply represented by that area, as also will be the quantity of electricity passing the section—the motive tension and the resistance opposed to it being also both constant. The electricity passing any one section of the conductor will be that passing all its sections in succession, and therefore that which may be received at each instant of time into the coil of a magnet, provided the sectional area of the wire of its coil be equal to that of the

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main conductor; from which it follows that the total quantity of electricity that can be in the coil *at one time* will be exactly represented by its length. Now reduce the diameter of the wire of the coil to one-tenth part, thus diminishing its sectional area to the one-hundredth part, and consequently reducing the electricity in each section to the same fraction of its former quantity; in order, then, to have in the coil *at one time* as large a quantity of electricity as did before exist in it under its unreduced diameter, it will need to be made a hundred times longer than at first, and if this additional length be not given to it there must be a lesser quantity of electricity rotating around its inclosed magnet, and its action upon the magnet be correspondingly weak. But this is not the whole evil that results from diminishing the diameter of the wire of the coil; for the increase in its length, which is thereby rendered needful in order that the quantity of electricity present in it may not be reduced, multiplies by 100 the period of time occupied in fully charging the coil, and thus, if the whole of the electricity be needed for producing the signal, the production of that signal will be delayed a hundred times longer.

Whether the coils of the signalling instruments which terminate the main wire of a telegraph may, or may not, be increased in diameter with advantage, will therefore depend upon this: if the coils be adequate,—under an existing intensity that determines their extent of conductivity, and under an existing motive tension and resistance that determines the velocity of conductive action,—to conduct *during the period of its supply* the whole quantity of electricity, then any enlargement of their diameters would be superfluous, or a reduction of the diameter of the main wire to their dimensions be unattended by prejudicial effect; but if, on the contrary, the voltaic elements be so large and so effective as to supply electricity *quicker than it can be conducted through the coils*, at the existing intensity and motive tension, then the diameter of the wires of the coils may be usefully augmented, even until made equal to that of the main conductor, supposing the latter to be only great enough for the conduction of the whole supply.

Whenever, therefore, we are using terminal coils of wire of smaller diameter than our main wire, and find that no increased effect is obtained from the substitution of other coils equally long and of larger wire, it is a plain indication that the main conductor is of larger diameter than is electrically useful; and that in order to get from it its maximum of service the voltaic elements require to be enlarged, the transmission of electricity from cell to cell to be made more rapid, or the supply of electricity to the conductor to be accelerated by a combination of both these means.

If my views be correct,—and no argument or fact has been publicly adduced that leads me to suspect them,—then what are called "resistance coils" should change their name, for they are virtually *conduction coils*, or, if we still continue to call them by their old appellation, the resistance should be understood to be that of popular parlance and not of scientific definition. There is nothing, however, in the manner of using those instruments that needs to be amended; for it is obviously the same thing in effect,—and hence the estimation in which they are held,—whether a given quantity of electricity be delayed in its arrival by a reduced conductivity, or by more perfect resistance—that is to say, by a practical diminution of the channel of communication, or an increase in its length; or by both of those causes acting conjointly, which in every instance must, in some proportion or another, be the case.

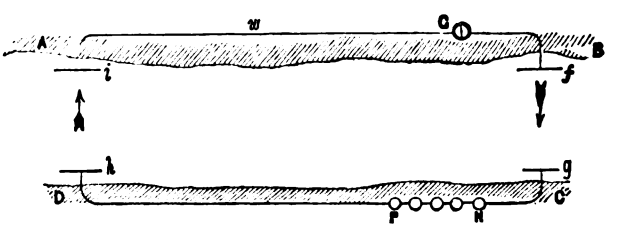
In conclusion; I do not expect the whole system of causation, of which I am too inadequate an exponent, to be at once seen into at all its parts, opposed as some of those parts are to convictions which it has long been regarded as presumptuous to question; but difficult as is the task, and feeble the unassisted hand that essays to execute it, truth speaks with so endearing a voice that, sooner or later, it must be listened to; and I hope to find, in the present instance, that the Editor of this journal will become convinced that the grounds of objection he alleged against the statement, quoted at the head of this article, have no real existence, and that he no longer denies its truth.

MODE OF CROSSING BROAD RIVERS, OR OTHER BODIES OF WATER, WITHOUT WIRES.

WE take the following from Alfred Vail's "American Electro-Magnetic Telegraph." The experiments are of interest, as being the first to show the possibility, if not the practicability, of signalling through a short distance without the use of an intermediate wire. Similar experiments have since been performed with a galvanometer placed in circuit near the battery, as well as at G in the diagram; thus showing the *proportionate* quantity of electricity traversing from *i to f*, at various distances, in comparison with the total quantity traversing the various paths of the circuit. In reference to this subject the reader is referred to our observations at p. 131 of the present volume.

The following extract from Professor Morse's letter to the Secretary of the Treasury, and by him submitted to the House of Representatives, Dec. 23, 1844, in relation to this interesting subject, will sufficiently illustrate it:—

"In the autumn of 1842, at the request of the American Institute, I undertook to give to the public in New York a demonstration of the practicability of my telegraph, by connecting Governor's Island with Castle Garden, a distance of a mile; and for this purpose I laid my wires properly insulated beneath the water. I had scarcely begun to operate, and had received but two or three characters, when my intentions were frustrated by the accidental destruction of a part of my conductors by a vessel, which drew them up on her anchor, and cut them off. In the moments of mortification, I immediately devised a plan for avoiding such an accident in future, by so arranging my wires along the banks of the river as to cause the water itself to conduct the electricity across. The experiment, however, was deferred till I arrived in Washington; and on December 16, 1842, I tested my arrangement across the canal, and with success. The simple fact was then ascertained, that electricity could be made to cross a river without other conductors than the water itself; but it was not until the last autumn that I had the leisure to make a series of experiments to ascertain the law of its passage. The following diagram will serve to explain the experiment:—



"A, B, C, D, are the banks of the river; N, P, are the battery; G is the galvanometer; *w w*, are the wires along the banks, connected with copper plates, *f, g, h, i*, which are placed in the water. When this arrangement is complete, the electricity, generated by the battery, passes from the positive pole, P, to the plate *h*, across the river through the water to plate *i*, and thence around the coil of the galvanometer to plate *f*, across the river again to plate *g*, and thence to the other pole of the battery, N.

"The distance across the canal is 80 feet; on August 24th, the following were the results of the experiment:—

No. of the experiment.	1st.	2nd.	3rd.	4th.	5th.	6th.
No. of cups in battery	14	14	14	7	7	7
Length of conductors, *w, w*	400	400	400	400	300	200
Degrees of motion of galvanometer	32 & 24	13½ & 4½	1 & 1	24 & 13	29 & 21	21½ & 15
Size of the copper plates, *f, g, h, i*	5 by 2½ ft.	16 by 13 in.	6 by 5 in.	5 by 2½ ft.	5 by 2½ ft.	5 by 2½ ft.

"Showing that electricity crosses the river, and *in quantity in proportion to the size of the plates in the water*. The *distance of the plates on the same side* of the river *from each other* also affects the result. Having ascertained the general fact, I was desirous of discovering the best practical distance at which to place my copper plates, and not

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having the leisure myself, I requested my friend Professor Gale to make the experiments for me. I subjoin his letter and the results.

"*New York, Nov. 5th*, 1844.

"MY DEAR SIR,—I send you, herewith, a copy of a series of results, obtained with four different sized plates, as conductors to be used in crossing rivers. The batteries used were six cups of your smallest size, and one liquid used for the same throughout. I made several other series of experiments, but these I most rely on for uniformity and accuracy. You will see, from inspecting the table, that the distance along the shores should be *three times greater* than that from shore to shore across the stream; at least, that four times the distance does not give any increase of power. I intend to repeat all these experiments under more favourable circumstances, and will communicate to you the results.—Very respectfully, L. D. GALE.

"Professor S. F. B. MORSE,
"*Superintendent of Telegraphs.*"

Series of Experiments on four different sizes of plates, to wit—1st, 56 square inches; 2nd, 28 square inches; 3rd, 14 square inches; and 4th, 7 square inches.

Experiment 1st.—Surface of one face of the copper plate, 56 square inches; battery, Morse's smallest, 6 cups.

NOTE.—In all the experiments, *f* and *g* are stationary.

Distance from bank to bank.	Distance along shore.	1st Trial	2d Trial	3d Trial	4th Trial	5th Trial	6th Trial
1	1	22°	23°	23°	22°	22	22°
1	2	31	32	31½	31	31	31
1	3	36	36	35½	35	35	35
1	4	36 sct.	36 sct.	34½	34	34	34

Experiment 2nd.—Plates 28 square inches, conducted as above.

Distance from bank to bank.	Distance along shore.	1st Trial	2d Trial	3d Trial	4th Trial	5th Trial	6th Trial
1	1	18°	17°	17°	17°	17°	17°
1	2	27	26	27½	27½	27½	27
1	3	31	31	31	31	31	31
1	4	31	31	31	31	31 sct.	31

Experiment 3rd.—Plates 14 square inches, conducted as No. 1.

Distance from bank to bank.	Distance along shore.	1st Trial	2d Trial	3d Trial	4th Trial	5th Trial	6th Trial
1	1	8°	8½°	8½°	8°	8°	8°
1	2	19½	20	19½	19	19	19
1	3	23½	23½	23½	23½	23½	23½
1	4	24½	24½	23½	23½	23½	23½

Experiment 4th.—Plates 7 square inches, conducted as No. 1.

Distance from bank to bank.	Distance along shore.	1st Trial	2d Trial	3d Trial	4th Trial	5th Trial	6th Trial
1	1	5°	5°	5°	5°	3°	3°
1	2	15	14½	14	15	15	12
1	3	17½	18	17½	17½	18	17
1	4	18	18	18	17½	17½	17

The distance from bank to bank, 30 inches. Depth of water, 12 inches. In experiment 4, the liquor of the batteries was very weak, exhausted towards the last; and in trials 5 and 6, the irregularities are to be attributed in part to the weak liquor, and in part to the twilight hour at which the experiments were made.

As the results of these experiments, it would seem that there may be situations in which the arrangements I have made for passing electricity across the rivers may be useful, although experience alone can determine whether lofty spars, on which the wires may be suspended, erected in the rivers, may not be deemed the most practical. The experiments made were but for a short distance; in which, however, the principle was fully proved to be correct. It has been applied under the direction of my able assistants, Messrs. Vail and Rogers, across the Susquehanna river, at Havre-de-Grace, with complete success, a distance of nearly a mile.

The Student.

SECONDARY BATTERIES.

THE letter of a correspondent, in our last impression, requiring several particulars in regard to the construction and action of secondary batteries, will be best answered by an article under this heading. A secondary battery may be regarded as a kind of condenser, or accumulator, of dynamic electricity, as it enables us to obtain, during a short space of time, powerful effects, either of tension or quantity, through the action of a comparatively weak source of electricity exerted for a much longer period. Let us suppose, for instance, that we are possessed of a battery of only four or five small Daniell cells, and that we require, at intervals, to send a powerful current through a very great resistance of wire; we may for this purpose construct a secondary battery for tension effects. We find that, if we attach to the poles of our battery two electrodes of platinum, and immerse these in a vessel of water, the platinum connected to the negative pole becomes, in less than a minute, strongly electro-positive, like zinc; while the platinum connected to the positive pole becomes a more efficient negative than platinum in its ordinary condition. Thus, if we remove the two pieces of platinum from their connection with the battery, and employ them as the elements of a voltaic cell, we shall be able by this means to produce a powerful, though temporary, deflection of the galvanometer, even through a considerable resistance. The tension of our secondary battery, however, will not, in this case, be equal to that of the small primary battery employed to excite the platinum plates; but we may attach *twenty* strips of platinum to the positive pole of our primary battery, and twenty to the negative pole; and, say in twenty minutes, these will be fully excited. We shall thus have twenty positive and twenty negative elements with which to construct a voltaic series of twenty cells. Now, let us suppose that the single secondary cell possesses an electro-motive force, or tension, equal to three elements of Daniell — five of which constitute the primary battery; the tension of the twenty secondary cells arranged in series will equal that of sixty elements of Daniell. It is necessary only to contrive an arrangement for conveniently alternating the connections, to enable us, by the action of a battery of five small cells, to obtain from a secondary battery at intervals of twenty minutes, a temporary current capable of giving powerful shocks, producing the arc of flame between charcoal points, &c. It is to be observed that our secondary battery, once constructed, will last for an indefinite period, and that no consumption of material takes place in it; though, of course, it necessitates the expenditure of zinc, &c., in the primary battery.

If, on the other hand, we require to obtain a powerful current through a circuit of small resistance, or what is commonly termed a "quantity" current, we may excite, by means of our small primary battery, a secondary couple of very large size. Mr. Planté has shown that if two large plates of lead, separated at every portion by canvass, are rolled up together, and connected respectively with the poles of a battery of five small Bunsen's elements, a temporary current of enormous quantity may be obtained from this secondary arrangement. The sheet connected with the positive (platinum) pole of the primary battery becomes the negative element of the secondary couple, and *vice versa*. We should recommend that the sheet attached to the negative pole of the primary battery, *i. e.*, the positive element of the secondary couple, should be of zinc instead of lead, preserving a lead plate for the negative element.

This secondary couple may be immersed in dilute sulphuric acid, no action taking place while the zinc is in connection with the negative pole of the primary battery, and the zinc dissolved while the secondary battery is in action, being subsequently recovered by electro deposition in again charging the arrangement. If, instead of one pair of secondary plates, several smaller pairs are used, they may either be contained in the same or in separate vessels; the negative (zinc) pole of the primary battery being connected to the zinc, and the positive (copper) pole of the primary to the lead, of the secondary couple or couples. According to the length of time during which the secondary battery is charged by the primary, the current from the latter may be either momentary, or, as we have found, lasting without any very considerable reduction of power for a space of fifteen minutes or longer. We have, by preference, employed for the primary battery a few Daniell's cells, which, although much less rapid in their action than the Bunsen cells, suffice for the production of the peroxide of lead, on which the efficiency of this secondary battery depends.

(*To be continued.*)

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THE HINDRANCES TO TELEGRAPHIC PROGRESS.

DOUBTLESS every reader of this journal is sincerely anxious for the advancement, not of telegraph science alone, which indeed progresses very satisfactorily, but of the practical application thereof, or, in other words, a progression in practical submarine telegraphy commensurate therewith; now this is where we are hitched—have our wheel become scotched?—if we may be allowed the use of a provincialism which obtains down in the country immortalized by the renowned Sir Guy and the Avonian Swan; and here, finally, every lover of progress passes his nervous fingers through his forelock and sends up the sigh of despair, because the latter keeps not pace with the former, but lags behind an immeasurable distance, as do our good deeds at the extremest tip of the tail of our virtuous intentions. Without stopping to inquire what amount of obstinacy, prejudice, ignorance, and interested motives there may be in the latter, or of empiricism, if any there be, in the former, which thus result in the unnatural and world-wide separation of these two, whose legitimate relationship should be undisseverable unity; we may venture the assertion that practical telegraphy, like every other beneficial work, has its probationary stage to pass through ere it attain to the lofty stand-point already occupied by the science; by which time we shall probably bruise our shins a countless number of times over all sorts of petty and provoking obstacles. But let us not get out of temper, we frequently kick against, and stumble over, the most preposterous little pebble which goes to the core of our corns, hard and soft; and if we feel a bubbling up of indignation, or any such like commendable feeling, let us glory in our privileges as Englishmen in being permitted unlimited use of the safety-valve for letting off all such superfluous steam; which we propose to do in the present instance, by chronicling some of the obstacles which still threaten to seriously impede the progress of the practical application of that science which lends its name to this weekly record of its history, rise, progress, and general setting-forth.

We may, to begin with, safely calculate upon no inconsiderable amount of the present general ignorance, in all matters appertaining to telegraphy, practical and theoretical. Of course there is a natural disinclination on the part of ninety-nine one-hundredths of humanity to apply themselves to the acquirement of any knowledge that lays an extra tax upon their mental faculties; and so this science, like all others, must ever remain to them a sealed book; this is a misfortune, because telegraphic science, however abstruse, is so closely interwoven in its practical workings with the necessities of man in these modern times as literally to necessitate a widely extended and general knowledge of its principles. This is a peculiar and distinctive feature of telegraphic science which we shall look in vain for in any other. Astronomy for instance, is a glorious science and amply repays the intellectual labour required to comprehend it, by the glimpses it affords you of infinite space; but it does not appeal to us in the same way; we do not invest money in the Pleiades, nor hold shares in the lead mines of the Moon. Ignorance, however, is an obstacle which time and a popular treatment of the subject in these pages will eventually mitigate considerably; and when we reflect that ignorance on any subject is the prolific parent of every other abuse, we may surely assume that as this is gradually dispelled all the others will be tolerably easy of dispersion. In the mean time, however, the herculean task remains to be done, and we herewith equip ourselves for the work; don't think us over presumptuous; the present means now being put forth by this chronicler are extremely humble, as he is fully aware, and perhaps only comparable to the mouse nibbling at the meshes which held in durance his leonine majesty, as per account of Doctor Fenning, but they are not to be despised for all that.

Prejudice, like superstition, is the ugly but legitimate offspring of the intolerable hydra above adverted to, and is a most formidable obstacle to the progress we are all so desirous of making. The quantity of this article fermenting in the brains of electricians, telegraph engineers, and the public generally, is truly amazing; but if, among the first-named, it were attributable to ignorance only we might indulge the hope, well-grounded, of its speedy extirpation: unfortunately, as I reconsider the matter, it turns out to be the bantling of more than one parent, otherwise it would not be found in these latitudes; indeed, in not a few instances I fear we should have some difficulty in tracing from son to sire, so that after all it becomes a matter of doubt if such relationship exist at all. The writer hereof is free to confess to the cherishing of certain prejudices which would puzzle him sorely to explain the why and the wherefore thereof without looking extremely ridiculous.

"I do not like you Doctor Fell,
The reason why I cannot tell," &c.

And there are some men of eminence whom posterity will doubtless delight to honour; can they give satisfactory reasons for the telegraphic faith that is in them, or account for certain prejudices, without making themselves appear inconsistent and preposterous? Shall I cite cases in point? Their prejudice in favour of gutta percha insulation, what is it worth, and on what grounds will it bear ventilation, or stand the test of critical examination? And the heavy cable prejudice; who, among the Mentors of telegraphic science, will favour us with valid and indisputable reasons for its still being entertained, and its use persisted in, to the utter emasculation of dividends if not of the absorption of the paid up capital. A pestilent fellow is this Prejudice, and an ingrate withal. How many numbers, O Prophet, shall be issued of this Journal ere we bring the recreant on his knees to sue for quarter? Doubtless as the mountain of ignorance melts away before the prowess of the knights-errant of the goose-quill, this fellow who sometimes lurks beneath its shadow will then begin to show symptoms of weakness in the joints, a sure prelude of ultimate prostration. So, relax not your efforts, redoubtable fellow scribblers, but lay in a good stock of feathers as well as facts, arguments, and ideas, and let us have proofs of your valour; there is a precious thicket to cut through, and the underwood is not altogether free from nasty thorns and other agreeable things which your fancy will save me the trouble of enumerating.

Then there is Monopoly; has it a genealogy? and, if it have, need I trace it? Beshrew its lineage, what have we to do with it; it is enough for us to know that it exists. Of all the evils with which humanity is cursed, this is one of the most rampant; it makes bad worse, and worse tenfold more than it would be, if it were permissible to trust English grammar in such a way. Unbleached calico is up 300 per cent., so says the housekeeper; an indifferent insulating material, badly constructed cables, interrupted communication, and a consequent all but insolvent condition of Submarine Telegraph Companies; these are the things which now reign predominant; for which favours, O most potent of deities, accept our thanks. Under its fostering care the afore-mentioned prejudice may grow up and flourish in the rankest luxuriance, for this state of things is profitable to some few persons, which end is highly desirable even if all the world beside should have to contribute, each man his quota, in order to uphold it. Why, O thou concentrated essence of discontent, should thou wish to disturb the beatitude of the few in order to consummate the general advantage of mankind?

"Let cables perish, rubber, all things die,
But God preserve us our monopoly."

Here is retardation if you like, for this is the most potent engine of obstruction that ever blocked up the path of telegraphic progress. It enables a second class insulator to retain almost absolute possession of the field, in spite of the universally acknowledged superior merits of its rival, of Government Committees, of the discoveries of science, and the results of improved manufacture: it causes cables to be made and submerged, laden in every inch of their entire length with the elements of effeminated weakness and ultimate distinction: it prevents the adoption of those improvements in science which have been secured in not a few instances at the price of the best part of the lives of men of surpassing skill and genius, whose labours are thereby rendered abortive, and the rest of their days probably embittered by non-appreciation and neglect. This, if you will, is the python, whose insatiate maw is ever open, and the burden of whose song is "Give, give," but which makes no commensurate return; if it did, we might be induced to tolerate an otherwise intolerable evil.

In times past, its obstructive tendency is legibly written, nor is the page difficult to decipher. At the present time it is a stumbling-block of no ordinary description, its pernicious workings are unmistakable, nor are the results, if left unchecked, difficult to determine. We have dwelt a little on these, and might do worse than enlarge thereon a little more. Of course a monopoly cannot exist without a millionaire, one or more as the case may be, and the influence of such an individual is in proportion to his social position, which again is regulated by the length of his purse; his influence, therefore, if he occupy that nicely balanced position between the aristocracy, including cabinet ministers, on one hand, and the merchant princes on the other, is most powerful in promoting whatever he may patronize, or whatever brings grist to the mill, although it be no more worthy of public favour than Captain Wragge's famous pill of "aloes, scammony, and gamboge." And this influence is no less indirect than direct; what a talisman his name is, how it operates upon public opinion, and permeates through the whole social fabric, especially if there be no adverse influence to counteract the charm. In the case of submarine telegraphy we find it is capable of making men forswear their honest convictions, and adopt a course which their own recorded words denounce. It is sufficient to cause years of valuable service, rendered by men of whom this country is justly

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proud, of no avail; it is also sufficient to render nugatory the combined experience of skill, wisdom, and genius, and to set at nought the results of scientific knowledge. And, to accomplish this desirable end, no stone is left unturned from wholesale prevarication to the reading of long-winded platitudes at art societies and similar institutions, having no other merit but that of eternally puffing up that which in all conscience is already sufficiently inflated.

And this monopolising spirit in telegraph matters is on the increase; the Report which has just appeared of the Telegraph to India Company is confirmatory of this:—One will surely be excused if he ask with every sentiment of deferential respect if the company in question have taken leave of their senses. If they have had the misfortune to lose all their capital through bad cables and telegraphic quackery, why don't they die like men, and not attempt to linger out an existence which can scarcely be considered anything more than to vegetate; although they assume a new name, high-sounding and sonorous, since after all they will only exist in sufferance, presuming there are sufficient greenhorns yet in the country to subscribe the requisite £50,000 capital. The matter is how will the public be served; since the tendency of monopoly is, as we have seen, inimical to all interests save its own: this question will be best answered by putting another:—How *has* the public been served? The charge for a message of twenty words to Alexandria is at the enormous rate of some 1s. 7d. per word, whereas it should be a successful commercial undertaking at less than a third of that charge; this is a specimen of how the public has to pay for inefficient cables, one of the legitimate results of monopoly. Again, the Malta and Alexandria cable, through which you may speak at the rate of three to four words per minute, should, if it were made of right materials and properly constructed, be capable of being signalled through at the rate of at least fourteen words per minute; of this line Messrs. Glass, Elliott, and Co. are now the lessees; and by degrees, if we are to judge from what has recently come to pass, the whole of this line of cables will pass into their hands; so that it is pretty certain cables in that direction will benefit but little by "recent improvements in the science of telegraphy." The cable from Cairo to El Arish, and, perhaps, to Beyrout, for which the almost defunct Telegraph to India Company is to pay them £20,000 in advance, and yet not be able to call one inch of it their own, will of course be after the same fashion; but what will that matter so long as a deluded public pay at the rate of 200 per cent. more for their messages than they ought, in order to make up to monopoly the profits they are determined to realise. Of course this is a matter which rests entirely with the public, and it is for them to decide whether they will continue to support companies which uphold monopoly, the inferior cables of which they must pay for in addition to the transmitting tariff; or whether they will insist on cables being laid which shall combine the most advanced scientific knowledge and the latest improvements in manufactures; for it is the general mercantile public which will take up the bulk of the proposed schemes, and indeed the shares of all telegraph companies of whatever locality; and therefore it is high time they began to stipulate for conditions prior to paying one shilling for such a purpose; and that such stipulations should be based upon the solid foundation of sound scientific principles, practical skill, and nautical as well as other experience. Finally, it is to the interest of the public to steer clear of all cables of which the makers are the ostensible owners, since such lines never can combine those desirable qualities which are absolutely essential in a thoroughly good submarine cable. Like everything else, if the manufacture of long lines of deep-sea cables cannot be submitted to public competition, the chances are that they will turn out comparatively worthless; for all Englishmen are by this time duly impressed with the beneficial results of a little wholesome competition and the baneful and paralyzing influences of monopoly.—M.

DEEP-SEA TELEGRAPHY.

The following letters have appeared in the *Journal of the Society of Arts*:—

SIR,—"Believe nothing you hear, and only half of that which you see," was the maxim inculcated by the late eminent hydrographer, Admiral Sir T. Beaufort, when I first took command under his direction in 1830.

I do not, therefore, allow mere assertion or opinion to satisfy me where facts should be forthcoming, and when I assert, it is with the intention of proof if needed. I allow every man his opinion, and, if suddenly advanced as an opinion, treat it merely as such; it may be reversed on reflection. I claim the same for myself. I never doubted "magnetic storms" and perturbations—having with others recorded them—but I doubt the aurora as a cause; it is matter of opinion even if it be a result. For myself, and my staff of observers, no disturbance was noticed under the presence of a vivid aurora. The magnetic disturbances I find, from my correspondence with the first authorities of the day, have been noted before, or after, or without the appearance of the aurora; and the same high authorities have no direct proof beyond opinion which will solve these matters. I have noticed as a peculiar fact that the aurora does not prevail much above the parallel of 70° north, and, further, that the period of its appearance in 1825-26-27-52-53-54, ranged about the 27th August. I leave this matter for the opinions of our *savans*.

Directly bearing on the laying down of deep-sea telegraphic cables—rate of sinking, and currents of great depths—I think the following data may furnish those about to discuss this question on the 11th instant with matter for previous thought, for it will be seen that the observations made by Sir James Ross and myself, at stations far asunder, nearly at the same time, and on the same meridian, possess a peculiar interest, and it was by mere chance I discovered that he had pursued precisely the same formula in noting his operations. In my own case I decided on using the smallest possible line with a lead of 12lbs.

Sir James Ross used spun yarn, with a weight of 340lbs.; in both cases line was sacrificed:—First, in H.M.S. *Samarang*, 20th March, 1843, 0° 24′ N., lon. 10° 37′ W., calm—weight 12lbs., line whipcord, sustaining 56lbs. to 1 fath.; the following result was obtained:—

No. 1.

DEEP-SEA SOUNDINGS AND TEMPERATURES, 20TH MARCH, 1843; LAT. 0° 24′ N., LONG. 10° 27′ W.; CALM; WEIGHT LEAD, 12lbs. LINE, WHIPCORD.

Fathoms.			Fathoms.		
0	...	2·57·38	1,600	...	3·53·35·2
100	...	2·59· 8	1,700	...	3·59·12
200	...	3· 0 56	1,800	...	4· 3·54
300	...	3· 3· 2	1,900	...	4· 8·24
400	...	3· 5·10	2,000	...	4·14· 7·2 = 51·34·0
500	...	3· 7·23·2	2,100	...	4·18·11·2
600	...	3·10·16·8	2,200	...	4 22·15·2
700	...	3·12·51·2	2,300	...	4·29·30
800	...	3·15·51·2	2,400	...	4·39 18
900	...	3·19·15·2	2,500	...	4·44·33·2
1,000	...	3·22·33·2 = 24·55·2	2,600	...	4·49·57·2
1,100	...	3·26·24	2,700	...	4·54·39·2
1,200	...	3·32·10	2,800	...	5· 0·26
1,300	...	3·36·57·2	2,900	...	5· 6·24
1,400	...	3·42·24 *	3,000	...	5·11· 0 = 56·52·8
1,500	...	3·48·27·2	65 broke.		

At 2,000 fathoms a second lead of 12lbs. was sent down by messenger, but it does not appear to have materially accelerated the descent.

		Per 100.
Thus we have for 1,000 fathoms	24·55·2	3·18
2,000 „	51·34·0	5·43
3,000 „	56·52·8	4·36
Time for 3,000 fathoms	2 ·13·22	

No. 2.

SIR JAMES ROSS IN H.M.S. *Erebus*, 3RD MARCH, 1843. LAT. 68° 34′ S.; LONG. 12° 49′ W.

	m.	s.		m.	s.	2nd diff.
First 1,000 fathoms	13	39	Rate 100 fathoms	1	50	
						— 0 33
2,000 „	21	35	„	2	23	
						— 1 44
3,000 „	32	19	„	4	7	
						— 0 22
4,000 „	44	16	„	†4	29	
Time for 4,000 „	1 51	49				

				lbs.	
3,000 „	1	17	33	 340	
					diff. 55 39
Samarang	2	13	22	 12	

ROSS AGAIN. LAT. 52° 10′ S. 336lbs.

Fathoms.	m.	s.
500	1	21
1,000	1	48
1,500	2	6

* The last 100 fathoms seemed to have struck and accelerated the motion. (Query current?)

† Curiously there is the same peculiarity in both instances, a sudden increased velocity,

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I was not before aware that Sir James Ross had observed so closely by time. His notations depended on the slack line, taking a mark overboard. In the *Samarang* the line was taken off with a strain, on a very delicate reel, measuring each fathom with a brazen circumference, each revolution indicated by a trochiameter attached to the nave. It will be seen that the noted difference in

100 fathoms, at 2,900, was 5′ 58″ but
at 3,000, „ 4′ 36″

and it suddenly broke at 3,065.

I have before observed that very delicate observations at a depth of 1,200 fathoms proved, at the Cape de Verds in 1830, and off the Galapagos, in the Pacific (Equator), 1838, that the current ran with equal velocity throughout the entire depth, and therefore we may anticipate a very strong action on any cable suspended between closely-situated elevations between this and Newfoundland.

Another unnoticed element, preventing any vessel from holding any absolute course over any proposed line, is that the "current-bearing" would prevent any vessel from observing any course but that which the elements permitted. The commander will do his best, but that will depend on his judgment under the circumstances. Any seaman would laugh at the idea of attempting to tow or lay down a cable *malgré* wind and currents.

I will add a few temperatures at the great depths to show that Sir J. Ross and myself found no extraordinary differences at 1,000 fathoms between the Equator and high southern (or northern) latitudes :—

No. 3.

TEMPERATURES AT EQUATOR.

SURFACE 79°.

Fathoms.			deg.	
300	...	...	46·00	
400	...	...	38·00	(?)
500	...	...	46·00	
600	...	...	45· 5	
700	...	...	47·00	
800	...	...	45·00	
900	42·0		40·25	
1000	39·5		42·75	

Belong to water bottle.

LAT. 35·50 S. 1·54 E. SURFACE 64·5.

300	...	...	47·25	
400	...	...	44·50	
500	...	...	41·50	
600	...	...	51·25	(Current ?)
700	...	...	39·00	
800	...	...	42·50	
900	...	...	41·25	
1000	...	...	39·75	

SIR JAMES ROSS. 52·10 S. 136·56 E.

SURFACE 43°.

150	...	...	42·00
300	...	...	41·00
450	...	...	40·00
600	...	...	39· 8

It has been observed that writers, not themselves the actors, have asserted as fact that which experience denies. It is well known that icebergs (I write from personal knowledge) travel at a rapid rate to windward, *ergo* impelled by deep water currents. How can the Gulf stream reach these shores without such unceasing action?—Yours, &c.,

E. BELCHER.

SIR,—I have read, with considerable interest, a paper by T. A. Masey upon "The Submarine Telegraph," as published in the *Journal of the Society of Arts*, January 30th.

Although it may appear invidious for a man to speak of his own works, useful and scientific, I feel assured that, as an Englishman, my fellow-countrymen will feel pleased to accord to me, in the national spirit of fair play, the merit which is simply due to my exertions.

Were it not that I have documentary evidence in proof of my assertions, I should feel greater diffidence in making the following remarks:—Should a man succeed in flying through the air from the Crystal Palace to St. Paul's, we should have hosts of parties claiming priority of the idea, despite the numberless records in proof that even the ancients possessed similar aspirations. The merit, nevertheless, of rendering the flight practicable and of interest to the outer world, would rest with the man who first proved, by a shorter flight, that the whole distance could be accomplished.

I claim to have taken the first practical steps towards the accomplishment of the Atlantic telegraph line, by connecting the easternmost point of Newfoundland with the continent of North America, it being self-evident that an Atlantic cable could alone render the necessary investment of capital productive, and that only by a clear demonstration as to its feasibility could such capital have been procured.

Step by step I worked the problem out, making the first survey across Newfoundland in anticipation of the undertaking, and laying the first submarine cable submerged in American waters. To myself, personally, was granted the first exclusive charter for constructing lines across Newfoundland, and I was associated in the second charter, conveying more extended privileges. I then constructed the line, resigning my duties only when the whole route between New York, Canada, and Cape Race was in perfect working order.

It is a matter of history in British America how Mr. Cyrus Field and his friends (who wished to appear before the world as the originators of so great an enterprise) interfered with my rights in connection with the Atlantic line; and I shall be pleased to show the public documents and extracts from the British and American press, in substantiation of such history.

At present, I confine myself to the following remarks:—That second upon the list of submarine cables, the following entry should, by right, appear:—

"1852. From Prince Edward's Island to New Brunswick, one conductor, No. 16, copper wire gauge. Ten No. 8, galvanized outside wires. Distance, 12 miles. Depth of water, 14 fathoms. Manufactured by R. S. Newall and Co. Imported and laid by F. N. Gisborne. Working 3 years.

The shore end of this cable was injured by ice during the third winter, and was so damaged afterwards by an ignorant repairer (who actually raised the whole of the cable in lieu of underrunning it), that it was found expedient to replace it by a new cable during 1856.

In conclusion, I would remark that I have seen the gutta percha covering of wire eaten through and through by marine animalculæ; and, secondly, from experience, I know that it is a matter of extreme difficulty to manufacture a cable with hemp or any other partially elastic outer covering. Mere specimens of cables are eminently deceptive as to the possibility of producing a similar article in greater lengths.

You are quite at liberty to make such use of this letter as you deem proper, and

I am, &c.,
F. N. GISBORNE.

REPORT OF THE DIRECTORS OF THE LONDON DISTRICT TELEGRAPH COMPANY.

THE annexed statement shows a net increase in the receipts for this Company of £1,406 7s. 4d., as compared with the corresponding period in 1861.

The annual income of the Company continues steadily to progress, as will be seen by the following statement, whilst the present rate of expenditure is about sufficient to provide for a remunerative business, as soon as the advantages and conveniences of the undertaking are sufficiently known :—.

Year.	Net Receipts			No. of Messages.	Stations open.
	£	s.	d.		
1860	1,609	19	1	73,480	52
1861	4,729	17	5	142,724	77
1862	7,955	7	10	251,548	84

A decrease has been effected during the past half-year in the general working expenses, and the shareholders will perceive that all current expenditure is now charged to the revenue account.

During the half-year some important maintenance expenses have been incurred: such, for instance, as reinsulating the wires along the Surrey Canal, renewing the whole of the batteries at the chief office, restoring several lines of communication damaged by the recent numerous and severe gales, and painting and strengthening the

comparatively from 3,000 fathoms. In the case of the *Samarang*, I was of opinion that the lead struck bottom, and the velocity of the current at that depth, 3,000 fathoms, drew the line more rapidly, and broke it. I suspect a similar action with Sir James Ross.

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greater portion of our overhouse system. The property has thereby been kept in a satisfactory and efficient state, and the directors are glad to find a considerable reduction in the maintenance expenditure has been effected, notwithstanding these exceptional charges.

A few additional contracts for private telegraphs have been undertaken, where desirable; and, amongst others, telegraphs have been provided between some of the stations of the London Fire Brigade.

The inactive state of trade and commerce in general, during the greater portion of the past half-year, has necessarily affected both the local and provincial traffic; but the directors are glad to find that the undertaking continues to progress, both in a commercial and social point of view.

Pursuant to the Articles of Association, two of the directors, Mr. William Austin and Sir Charles Bright, retire from the board, but, being eligible, offer themselves for re-election. The auditors, Mr. Morris Chubb and Mr. Edward Sandell, likewise retire, and offer themselves for re-election.

Dr. SHARE ACCOUNT. *Cr.*

	£ s. d.		£ s. d.
To Capital authorized viz. :— 12,000 Shares, at £5 each.	60,000 0 0	By Shares unissued, 1,260 at £5	6,300 0 0
		Capital called, viz. :—	
		Deposit £1 per Share £10,740	
		Call (1st), £1 per Share 10,740	
		„ (2nd), 10s. „ 5,370	
		„ (3rd), 10s. „ 5,370	
		„ (4th), 10s. „ 5,370	
		„ (5th), 10s. „ 5,370	
		„ (6th), 10s. „ 5,370	
		„ (7th), 5s. „ 2,685	
		„ (8th), 5s. „ 2,685	53,700 0 0
	£60,000 0 0		£60,000 0 0

BALANCE SHEET.

To Capital called ... £53,700 0 0		By amount expended as per last account ... £36,008 18 4	
Less calls unpaid . 2,892 5 0	50,807 15 0	Subsequent expenditure, viz. :—	
Sundry Creditors	2,394 3 5	Construction of works and office fittings ... 167 18 2	36,176 16 6
		Instruments, batteries, stores, tools, implements, and furniture	4,008 8 5
		Frank stamps in hand	19 4
		Shares purchased in trust for Company	724 10 0
		Sundry debtors	1,704 10 3
		By Cash at Bank, &c.	947 9 5
		Balance of profit and loss account, as per previous account ... £8,745 4 2	
		As per account, 31 Dec., 1862. 894 0 4	9,639 4 6
	£53,201 18 5		£53,201 18 5

PROFIT AND LOSS ACCOUNT.

To Rents, rates, taxes, &c. £1,668 5 7		By Revenue from messages, rents of private wires, &c. £6,952 18 2	
Less rents of premises sub-let 575 13 0	1,092 12 7	Less charges of other companies 2,953 15 0	3,999 3 2
Gas and water rates, coals, &c.	106 10 6	Interest on unpaid calls, &c.	64 0 8
Direction	125 0 0	Transfer fees	1 0 0
Audit	15 15 0	Balance	894 0 4
Salaries	367 10 3		
Wages, &c.	2,231 8 5		
Stationary	241 10 6		
Printing, Postages, &c.	75 9 11		
Repairs and maintenance.	537 3 1		
Porterage and travelling expenses	49 6 3		
Charges	115 17 8		
	£4,958 4 2		£4,958 4 2

We have examined the foregoing statements with the vouchers and the Company's books, and find the same correct.

London, 10th February, 1863. M. CHUBB, EDWD. SANDELL, } *Auditors.*

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.

BALANCE SHEET.

	£ s. d.	£ s. d.		£ s. d.
Consolidated Stock 719,900 0 0			Total cost of the construction of the Electric and International Telegraph	914,155 16 9
New Consolidated Stock (7,199 Shares consolidated) 2nd Dec., 1862 ..... 179,975 0 0		899,875 0 0	Channel Islands Telegraph	4,200 0 0
Debenture Debt		75,550 0 0	New Central Station and Camden Stores	23,164 16 8
Fire Insurance Fund		369 2 3	Value of House Property in London	10,276 14 7
Balances due to Sundry Creditors		42,934 6 5	Balances due from sundry Debtors	57,761 12 3
Undivided profit 30th June, 1862, less carried to Trust Account		6,362 0 2	Calls in arrear	310 0 0
TRUST ACCOUNT.—			Value of Stores	41,493 5 11
Balance 30th June, 1862	26,061 6 7		Securities in hand	2,710 13 6
Half Year's Interest ...	356 16 2		Trust Account agreed to at the Half-Yearly Meeting, 31st July, 1858	4,837 17 0
Surplus 30th June, 1862	1,419 14 3		Balance at the Bankers' ...	11,274 11 10
	27,837 17 0			
Further Advance on account of New Zandvoort Cable	23,000 0 0	4,837 17 0		
Deposits on account of New Shares		4,129 10 0		
Balance of Revenue Account as under		36,127 12 8		
		£1,070,185 8 6		£1,070,185 8 6

REVENUE ACCOUNT.

			£ s. d.
Receipts for Messages, Subscriptions, Intelligence, Maintenance Contracts, Interest, and Transfer Fees			121,347 17 3
Less Porterage paid out			4,273 3 2
			117,074 14 1
Salaries and Wages		33,215 2 3	
Station Expenses		2,801 12 0	
Rent, Taxes, Gas, and Insurance		6,988 4 5	
Books, Stationery, and Printing		3,789 14 7	
Postage		159 8 10	
Newspapers, Lists, and Reports		796 7 5	
Law Charges		325 6 4	
Continental Agency		748 2 1	
Direction and Audit		1,200 0 0	
Maintenance, Labour	£9,404 15 1		
„ Materials	13,149 10 6		
		22,554 5 7	
Contribution to Sickness Fund		125 5 8	
Cost of repairing Submarine Cables		2,485 10 9	
		75,179 19 11	
Interest on Debenture Debt	1,204 18 7		
Interest on Loans	306 13 3		
Interest on Calls paid in Advance	159 9 8		
		1,662 1 6	
		76,842 1 5	
Outlay on Liverpool and Manchester New Wires	4,000 0 0		
Lancashire Relief Fund	105 0 0		
		4,105 0 0	
			80,947 1 5
			36,127 12 8

Examined and found correct, JAS. ROLLS, ALEX. SIM, } *Auditors.*

January 31st, 1863.

GENERAL BALANCE.

	£ s. d.		£ s. d.
Dividend on £719,900 Consolidated Stock at £3 10s. per cent. for the half-year ending 31st Dec., 1862	25,196 10 0	Balance after payment of dividend, 30th June, 1862	7,781 14 5
Dividend on £179,975 New Consolidated Stock at £3 5s. 4d. per cent. (being at the rate of £3 10 per cent.) for the half-year ending 31st December, 1862	5,879 3 8	Carried to Trust Account	1,419 14 3
Undivided profits to June 30th, 1862 ... £6,362 0 2			6,362 0 2
Balance after payment of dividend ... 5,051 19 0		Balance of Revenue Account, 31st December, 1862	36,127 12 8
	11,413 19 2		
	£42,489 12 10		£42,489 12 10

February 3rd, 1863. ROBERT GRIMSTON, *Chairman.* J. S. FOURDRINIER, *Secretary.*

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THE SUBMARINE TELEGRAPH.

BY THOMAS WEBSTER, M.A., F.R.S.

THE responsibility of bringing this subject forward this evening having unexpectedly devolved upon me, I beg to tender my thanks to the Council for so promply responding to the suggestion that the discussion on the subject of submarine telegraphy should be resumed. This room appears peculiarly fitted for a subject involving so many questions of physical science, practical knowledge, and commercial enterprise; questions which, taken in the aggregate, are beyond the scope of any of the many admirable societies of which this society was the parent; and those who are acquainted with the way in which the society has promoted and fostered the arts, will feel how fitting is the great social question of submarine telegraphy for the exercise and concentration of its energy and influence.

The paper of Mr. Masey has gone far to exhaust the history of the subject. On the present occasion it is proposed to direct attention to some practical considerations which lie at the basis of the successful solution of Atlantic telegraphy, as it would be matter of deep regret that another failure should take place, or even that another attempt should be made, until every precaution, suggested by past and present experience, should be taken to ensure the success of this noble enterprise. It would ill become us to disregard the warning conveyed in the concluding paragraph of the Report of the Commissioners, "that the failure of the existing submarine lines is due to causes which might have been guarded against had adequate preliminary investigation been made into the question."

This subject naturally resolves itself into the questions of the route, the cable, and the means of submersion.

Public attention has been directed to three routes across the Atlantic—the Central, the Northern, and the Southern, each presenting peculiar advantages and difficulties. The Central Atlantic, or the route from the West Coast of Ireland to Newfoundland, a distance of 1,700 geographical miles, was that to which attention was directed in 1856, as presenting a submarine plateau in the nature of a gently levelled plain, of a depth inaccessible to the anchors of vessels, and yet not so far depressed as to present serious difficulties in the submersion of the cable. The surface of the bottom of the ocean on the proposed route is said to be a portion of a great zone of table land, smoothly strewn with a deposit of shells as the sand of the sea-shore in a tranquil bay.

The history of the Atlantic cable laid on this route must ever be regarded with the deepest interest. That the cable should have been submerged and safely deposited on the bottom of the ocean, and have spoken at all, was a triumph of skill amounting almost to a miracle.

Since that great experiment much precise information has been attained as to the working and the speed attainable in circuits of great length. It appears to have been ascertained that the rate of working a number of signals transmissible through two lines identical in every respect except as to length, is inversely as the square of the ratio of the lengths, that is to say, the speed of transmission, or number of words passed through a cable 600 miles in length, would be nine times as great as through a cable of 1,800 miles. This, which depends on a physical law of nature, is wholly independent of artificial and external conditions, as the insulation, which, however perfect, cannot affect the comparative results, and the shorter must always have a commercial advantage over the longer cable, which must necessarily influence the selection of routes. These and other considerations have called attention to two other routes for the Atlantic telegraph cable; one, the northern, from the west coast of Scotland, by the Faroe Islands, Iceland, and Greenland, to the east coast of Labrador, and the southern from the south coast of England, by the Canary and Cape Verd Islands to St. Paul, a small island in the South Atlantic Ocean, and thence by the Island of San Fernando to Brazil, and so along the coast or British Guiana and the West India Islands to America.

Both these routes present a convenient mode of dividing the distance into a series of short and manageable circuits, as in the case of the Government cable between Malta and Alexandria, which is divided into three, by the establishment of intermediate stations at Bengazi and Tripoli, and the cable in course of construction to connect India with Europe by way of the Persian Gulf. One main object of such division into separate circuits, is to ensure a high speed of transmission, and one which may yield a profitable return upon the outlay; and this is of the greater importance at the commencement of such an undertaking, as it is stated that the actual numerically productive rate is not more than one-third of the highest attainable rate through a submarine cable,

The southern route, whatever its commercial or other advantages, has not as yet been adequately surveyed, and may, therefore, for the present, be dismissed.

The northern route presents the advantages of short circuits, and has been surveyed by Sir Leopold McClintock and Captain Allen Young, to a sufficient extent to enable a judgment to be formed on its suitability for the purpose, and since 1860, the state of knowledge as regards the northern is in almost the same position as the state of knowledge was in 1856 as regards the central route.

The northern route would present four sections of the following distances, according to the results of the survey above referred to, viz:—

I.	Scotland to the Faroe Islands . .	225 miles
II.	The Faroe Islands to Iceland . .	240 ,,
III.	Iceland to Greenland	670 ,,
IV.	Greenland to Labrador	510 ,,
	Total :	1,645 miles.

The laying of the cable for these distances, and its submersion to the ascertained depths, will present no serious difficulties. The bottom of the ocean on the northern route is said to consist of shells, weeds, crustacea, with other animate and inanimate productions, presenting a favourable bed for the cable. The number of shore ends on this route, namely, eight at the least instead of two, presents a disadvantageous comparison with the central route, and is a subject for serious consideration in the selection of the route. The disadvantages of the northern route are the character of the region, in which the laying of any cable could go on only during a certain few months in the year, the icebergs and glaciers, and the volcanic character of the arctic regions. It must be borne in mind that the cable, when submerged, is at the bottom and not at the surface of the sea of those ice-incumbered regions, and that anchors, creepers, and trawl-nets, are more formidable enemies of a submerged cable than the floating icebergs, whose under surface is gradually diminishing under the more genial temperature of the lower strata of water. The submerged cable in the Northern Atlantic, would, in the opinion of the most experienced sailors, run little risk of damage, from such causes, whether from the Arctic storms, however terrible, or from the clash and destruction of icebergs on the coast of Labrador in a winter's day, whatever may be feared from the volcanic and magnetic character, or from the aurora borealis of the region, or from the impossibility of repairing a damaged cable in the winter time between Iceland and Greenland or Greenland and Labrador.

The selection of the central or of the northern route must, as in other cases, be matter of compromise, after mature examination into all the circumstances of the case. An accurate knowledge of the bottom of the ocean is of the greatest importance to such a question, but even this knowledge may be bought too dear. Soundings in deep water, say from 1,500 to 3,000 fathoms, over a breadth of four or five miles, present serious difficulties and would occasion a delay unfavourable to the success of the enterprise. Such lines of soundings, if attained, could not be kept during the submersion of a telegraph cable occupying many days and nights, during a considerable portion of which, in the fogs and the average weather of the Atlantic, no observations can be taken, while the speed of the vessel must frequently be so slow as to render her more than usually liable to get out of her course. A uniform level plateau, however desirable, is in no respect essential to the submerged cable, for the ridges and inequalities at the bottom of the ocean, in deep soundings, are not sharp knife edges likely to cut through a protected cable, which, in such places is incomparably less liable to injury than a cable in shallow water, subject to abrasion on a rocky bottom, or to the action of anchors. The time is probably not far distant when cables will be laid on all of the three Atlantic routes, as well as on the Russian route, by Siberia and the Aleutian Islands, but in the inception of the important enterprise of the telegraph between Great Britain and the Western World, every energy should be concentrated on that route which affords the best prospect of the earliest and greatest commercial success.

The question of the cable is secondary to the selection of the route, as the weight, dimensions, and construction of the cable would in all probability be different for the central or northern Atlantic. The weights of some of the principal cables are as follows:—

Punard to Zandwort	11 tons per mile.
Boulogne to Folkestone...	10 ,,
Orfordness to Haerlem	9¾ ,,
Dover and Ostend	8 ,,
Frith of Forth...	8 ,,
Corsica to Sardinia...	8 ,,
Dover to Calais	7 ,,
Malta and Sicily	3½ ,,
Malta and Alexandria	2½ ,,
Red Sea	1¼ ,,
Atlantic	1⅛ ,,

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The heavy cables at the head of the above list are submerged in shallow water, and in situations for the most part liable to considerable risk from anchors and other interferences. The Atlantic cable is only about one-tenth the weight per mile of the heaviest of the above, and many persons of authority and experience in submarine telegraphy advocate a much lighter cable, one whose specific gravity shall not be greatly in excess of water.

The constructive submersion of the cable involves several important questions. Exception has been taken to the spiral laying of the outside or protecting wires of iron as having a tendency to throw the strain on the insulated conducting wire of copper, as well as to compress and displace the insulating material. The pressure of the water at great depths will have a tendency to compress and condense the insulating and other materials of the cable, but owing to the equality of pressure on all sides, there will be no tendency to displace that material as originally disposed in the cable, however great the compression or distension by the elongation of the cable, in reference to which, however, it must be borne in mind that the relative ductility of copper and iron is in favour of copper, so that the iron wires, unless the spire of the coil was considerable, would practically bear the strain.

The pressure and strain to which a cable may be subjected, and their effects on the insulating material, whether gutta percha, india-rubber, or any of the compounds or products of modern science, may be ascertained by careful experiment and observation on land. Much may also be done in observing the effects of temperature on the insulating material under pressure, and the collective wisdom of men of science might do much towards arriving at a correct opinion as to the effects of magnetism and the aurora borealis on the submerged cable, and whether the effects would differ in kind from the disturbances which the telegraphic instruments experience during lightning and other electrical exhibitions, the laws of which, thanks to the labours of General Sabine and Admiral Fitzroy, are becoming gradually developed.

The laying and submerging of the cable involves geometrical and mechanical questions, which may also be reduced to certainty by experiment. The tendency of lines to twist, as observed in deep-sea soundings, is a source of difficulty in paying-out and submerging a telegraphic cable. The spirals of the cable afford an easy passage or line for the water, and, as the cable is paid out, the turns will accelerate; this prejudicial effect may be modified and corrected by care in the coiling and laying of the cable.

The character of the curve assumed by a cable, as laid in the water, will depend on the rate of its sinking and of its paying out, that is, the rate of the ship. If the cable sinks faster than the speed of the ship, the concavity of the curve will be upwards, or towards the surface of the water, and the convexity of the curve towards the bottom; but the cable in attaining this position will have presented a curve having a contrary flexure, in the language of geometricians, which, in a cable of great weight and thickness, may lead to serious inconveniences.

If the cable should sink less rapidly than the speed of the vessel, the curve of the cable will be convex towards the surface, and concave towards the bottom of the water.

The motion of the vessel being necessarily irregular, those curves will become irregular, so that a portion of the cable may be deposited in coils or waves on the bottom of the ocean, and afterwards drawn together into what are technically called kinks, from which serious inconveniences have resulted.

The existence of such curves of contrary flexure are unavoidable, in paying out a cable, whether lowered vertically or inclined, if the paying out is checked on board the ship, as it must inevitably be in laying a heavy cable. The consequences of the position assumed by the cable under a heavy sea may be very serious; so long as the cable lies away from the vessel in a position assumed by a chain cable when taut by a vessel at anchor, the vessel and cable will rise with the wave. But, if the cable becomes vertical, inasmuch as a heavy body like a vertical rope, cannot be lifted vertically on a sudden jerk, without an enormous strain, the rapid lifting of a vessel by the waves of the Atlantic may produce a strain which may injure or even break a cable so lifted; hence the necessity of having recourse to very elaborate machinery in the laying of the Atlantic and other heavy cables.

These and other difficulties connected with the submerging of heavy cables, have given rise to suggestions for making the cable as light as possible consistent with strength, and of a specific gravity but slightly in excess of water. Such a cable could be laid on the water from a vessel steaming at its full speed, a great length of cable lying nearly horizontally on the water, and sinking gradually at a slow rate, and adapting itself to the irregularities of the bottom. The cable would be subjected to a tension due to the velocity of the current of water through which it was being submerged; the tension due to the weight may be disregarded in such a cable, whereas in a heavy one the tension is due to the weight, and the tension due to the current may be disregarded. In laying such a light cable the tendency of the cable to run out or slip away from the vessel is so slight, that the elaborate regulating machinery required in laying heavy cables, for preventing the cable slipping away will be unnecessary and may be dispensed with. Whatever may be the tension due to the action of the currents, either on a light or a heavy cable, the tension due to the weight of the latter must be superadded, and the tension from the action of the current on the enlarged surfaces of the heavy cable will not be inconsiderable, so that the total tension on a heavy cable is a very serious amount.

Viewing the laying of the cable on theoretic principles, with reference to the action of the resisting forces, the light cable would appear to present so many advantages over the heavy cable, that the adoption of the latter in preference to the former will depend on other considerations, the result of actual experience.

The strain to which a cable is subject during the laying may be accurately determined by experiment and calculation, and this part of the question may be placed in the same category as the effects of temperature, of pressure, of extension, or of the comparative qualities of different insulating materials.

On the best construction of cable, whether a combination of insulated copper wire laid centrically and spirally, protected by the iron wires laid straight, or nearly so, with hemp, asphalte, and similar materials, or other of the various combinations suggested; also on the best system of insulation or insulators, whether gutta percha, or india rubber, or compounds thereof, or other substances now in existence, and already, or hereafter, to be applied, an inquiry conducted by competent persons may lead to the most important results.

In conclusion, I would suggest whether this society may not be able to promote and facilitate such an inquiry, and materially to contribute to the solution of the question of the best system of telegraphic communication with the great American continent.

We are compelled most reluctantly to defer until next week the discussion which took place after the reading of Mr. Webster's paper at the Society of Arts.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para First Quality	2s. 1d.	per lb.
Second „	1s. 7d. to 1s. 10d.	„
Third „	1s. 2d. to 1s. 3d.	„
Java	1s. 5d. to 1s. 6d.	„

GUTTA PERCHA.

Fine, none worth 2s. 6d. and upwards.

Genuine mixed	1s. 8d. to 2s. 1d.	per lb.
Reboiled good	1s. 5d. to 1s. 9d.	„
Ordinary Reboiled	1s. 0d.	„

February 18, 1863.

WM. KIRKMANN,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	62 to 69	
Stock	Electric Telegraph . .	100	97 to 100	
25	Do. New	all	— xd	xd
5	London District Telegraph .	all	1½ to 2	
10	Mediterranean Extension Tel.	all	3 to 4 xd	
1	Submarine Telegraph, scrip. .	all	½ to ¾	
1	Do. registered . . .	all	½ to ¾	
10	Do. „ . . .	all	5 to 7	
2	Telegraph to India . .	1	¾ to ½ dis.	
5	United Kingdom Telegraph .	8	¼ dis. to ¼ pm.	

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

THE EFFECT OF THE PRESSURE OF THE SEA AT GREAT DEPTHS UPON FIBRES, &c.

To the Editor of THE ELECTRICIAN.

SIR,—Admiral Sir Edward Belcher, in his letter to the Secretary of

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the Society of Arts, observes, "It is worthy of note in these proceedings that the pressure of the sea at great depths destroys the fibre: and it will be found in Scoresby's remarks, that whale lines which had been (some hours only) at bottom, attached to harpoons in the whale, were rendered useless." The following experiment made at the Government Telegraph Committee's works in 1861, with the view of ascertaining the effect of hydraulic pressure upon various fibres, will, I trust, lead to some further inquiries upon so important a subject. Having had to test the effect of pressure upon gutta percha and india rubber insulated wires, which for the purpose were placed in long hydraulic iron pipes (fully described in Appendix 6 to the Government Report), it was necessary, in order to withdraw the wires from the pipes, to attach to one end of each wire a length of tape, which remained in the pipe during the application of the pressure (three tons on the square inch, equivalent to a depth of 3,190 fathoms). I found that, after being subjected to pressure, the strength of the tape had been destroyed, and it consequently failed in the purpose for which it was intended. Again, I tried twine and whipcord—the former became destroyed and the latter partially so—it had a flabby touch and appearance. I next tried a strand of tarred hemp taken from the sheathing of the proposed deep sea portion of the Rangoon cable (now the Malta and Alexandria), which was subjected to the above-mentioned pressure for about eleven weeks. I could not discover that pressure had had any deteriorating effect upon its texture or strength. Having mentioned the above facts to Captain Galton, the Chairman of the Commission, with his permission I selected various specimens of sheathing for submarine cables, such as Sinnock's, De Berque's, Wells and Hall's, Silver and Co.'s, Allan's, Rangoon Cable, Godefroy's, &c., and also specimens of cotton, flax, jute, hemp, &c., had the whole placed in a cast-iron hydraulic press, and subjected to a pressure of three tons to the circular inch, but the pressure was only sustained for a few minutes in consequence of the bursting of the press; however, even this brief duration of pressure had had an injurious effect upon a few of the untarred materials. The experiments were not repeated, as the small fund placed at the disposal of the Experimental Committee had been exhausted.—Yours, &c.,

OWEN ROWLAND.

INSULATING COMPOUNDS AND HOT CLIMATES.

To the Editor of THE ELECTRICIAN.

SIR,—In the discussion before the Society of Arts, upon Mr. Webster's paper on "Submarine Telegraphy," Mr. Walter Hancock—no mean authority—makes the following remarks:—"Referring briefly to the moot point of the value of intermediate compounds, and specially to that one known by the name of Chatterton's compound, he stated that too much reliance should not be placed upon them, because it was evident, from the *rationale* of their operation, that they improved insulation in inverse proportion to the otherwise defective state of the work upon which they were employed; and because they rendered the gutta percha upon which they were employed more susceptible to the *injurious effects of heat, either in warm climates or in the hold of a ship.*"

Mr. Latimer Clark, in his report (see Appendix to the Report of the Government Committee, page 328), speaking of Chatterton's compound, states:—"The compound itself is an extremely perfect insulator, *but is not well adapted for use in hot climates on account of its ready fusibility.*"

The underlining is my own. We all know that Stockholm tar and resin are excellent insulators—*for a time.*

Mr. Cromwell F. Varley, also, in his evidence before the Government Committee (see page 164), states:—"In the case of Chatterton's compound, the compound penetrates the thinner layers (of gutta percha) to a much greater depth, and then, in the place of water (query the permanent insulating principle), in some of the pores you have Chatterton's compound." And yet we find that the principal ingredients forming this compound are Stockholm tar and resin—excellent insulators, but perishable.

The cry against all new insulating materials is: "they have not been tried long enough." Yet the favoured compound, allied to the disasters of the Red Sea, the Algerian cable, &c., is apparently more and more in demand. I believe that gutta percha, in a pure state, is imperishable in sea water, and is well adapted for submarine telegraphy, as long as it is not subjected to extreme heat, so as to endanger the central position of the conductor. With regard to Stockholm tar, when subjected to a certain degree of warmth, the volatile oil will gradually evaporate, leaving at first a viscous, and afterwards a vitreous, residue (and such residue will be found to exist between the layers of the Red Sea coatings) in the form of a resin, *i.e.*, an inferior and exceedingly capricious insulator. In some instances I have found almost the whole of the compound absorbed into the gutta percha, leaving a space between the coatings—a very serious fault.

OMICRON.

ELECTRIC SIGNALLING WITHOUT DIRECT WIRE COMMUNICATION.

To the Editor of THE ELECTRICIAN.

SIR,—In your report last week of the discussion on Mr. Macey's paper at the Society of Arts, mention is made of an experiment by Mr. C. Varley on the transmission of electric signals without wires. Mr. Varley states that the experiment was performed on a very small scale in his own garden, that the two stations were only eight yards apart, and that, though he employed twelve cells of Groves's battery, *and a reflecting galvanometer of the most sensitive kind*, he could not get any signals! The theoretical misapprehension involved in the portion of the preceding phrase which I have underlined sounds almost ludicrous, coming as it does from such an authority as Mr. Varley. This gentleman also states that he would have been very much surprised if he had got any signal, "as it was contrary to the well-known electric laws." It is tolerably evident that Mr. Varley must himself be imperfectly acquainted with the electric laws relating to earth conduction, and that he has not read your recent exposition of the subject, or, by simply replacing his delicate galvanometer by a few turns of stout wire, he might certainly have obtained the signals.

What is obviously required in an experiment of this kind is to oppose as little resistance as possible to the current of derivation through which the signal may be produced. The resistance of a galvanometer "of the most sensitive kind," must clearly be enormous in comparison to that of the other paths through which the electricity is free to pass. Hence Mr. Varley has only as yet tried the way "not to do it." Since the question of signalling without wires was first referred to in THE ELECTRICIAN, I have myself, with a less power than twelve cells of Grove, obtained signals through more than eight yards of garden ground; but it is well known, though Mr. Varley appears to have forgotten the fact, that signals have been transmitted without wires through a much greater distance, both in England and America.—Yours, &c.

STUDENT.

To the Editor of THE ELECTRICIAN.

SIR,—In your report of the proceedings at the meeting of the Society of Arts on the 28th ult. you represent Mr. Varley, in speaking of a discovery recently made by myself, as saying that he had tried certain experiments which had proved unsuccessful, with an apparatus constructed "under" my "direction." I beg to say that no apparatus has been constructed under my direction, except those in my own possession.

In the short and only interview I have had with Mr. Varley, a few general remarks were made about the apparatus, but I referred him to my published specifications for information as to its construction, &c.

I never stated that Mr. Grove had seen it in operation. I am quite certain that had Mr. Varley strictly followed the specifications, he would have received signals. Perhaps old materials were used, in which the insulation was imperfect. I never saw Mr. Varley's apparatus on any occasion.—Yours faithfully,

JOHN HAWORTH.

Feb. 16th, 1863.

CONDUCTIVITY AND RESISTANCE.

To the Editor of THE ELECTRICIAN.

SIR,—Of the competence of your correspondent Mr. Laming as an authority in electrical matters I cannot presume to judge, but one who has written so much must no doubt have thought more upon this subject, and hence his opinions are entitled to the gravest respect from the junior stools in the electrical office.

When, therefore, he takes pains to become "more than ever explicit," we ought to hear and implicitly believe, and I, for one, did so, while Mr. Laming kept to the short lengths of homogeneous cylindrical wire, or, analogically, short water-pipes; but when he began to couple them together and then got "the same quantity of electricity in the same time" out of the last part as he could from the first part, faith wavered, nay, died within me, yet rose again when I found the saving clause premised, that "the first part must receive its supply from *an adequate source*—an ambiguous term in this case used to imply that the increase in length must be accompanied by increased initial force or tension at the source. In this sense Mr. Laming is perfectly correct in stating "that conductivity is unaffected by the length of a conductor," but he is just as far in error a little farther on when he condemns the expression of "London District" as being "in opposition to truth," since it is the very "want of conductivity," or the absence of *perfect* conductivity, or the more familiar, yet equally expressive and correct term, "resistance of the conductor," that renders it necessary to apply an *adequate* source to the long length of wire to obtain the same evolution of electricity as that given off from the short length, to which, of course, an *adequate* source is also applied. As my excuse for repeating the word *adequate* so often, I may mention, *en passant*, that a friend of mine who has not yet climbed the "First Step to Theory," having read Mr Laming's article would not believe but that as the word adequate meant "equal to," the writer implied that the *same* source should be employed whether long or short circuit was used. This same friend, "whose name it is Mr. Harris," was still louder in inveighing against Mr. Laming's theory when he came to that part of the paper to which you have objected by a foot-note, viz., "Hence a large conductor with small ends can act no better than another conductor small throughout its entire length." Here not only known facts in electrical science, but the hydraulic analogy fails to support Mr. Laming, since it has long since been established that if water flows through a pipe contracted in any portion of its length, the result is not to decrease the conductivity of the

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pipe to that of one of the least section throughout its entire length, but, on the contrary, it increases the velocity of the water while passing through the contracted part reciprocally as the transverse sections of the larger and contracted parts, so that, with an "adequate source," precisely the same quantity of water would pass whether the pipe were contracted or not. *Vide* "Hutton's Mathematics," article "Hydraulics." Analogically the same result would obtain in an electrical conductor. It may form part of Mr. Laming's philosophy "to laugh to scorn the engineer who would finish a magnificent conduit by dwarfish extremities," but where would he laugh the same engineer to if that gentleman should continue a water main into a house to act as a service pipe, and expect the cook to fill her kettle from a sixteen-inch sluice valve in lieu of a common tap? Yet this is what he really asks Electricians to do by analogy in a telegraph office; an innovation found practically to be quite useless, and (as clearly explained in "London District's" letter) quite impracticable. —I am, sir, yours respectfully,

RELAY MAGNET.

To the Editor of THE ELECTRICIAN.

SIR,—I wish to attract the electricity from the air, and should feel much obliged if you, or any of your numerous correspondents, would inform me at what height a wire should be placed so as to obtain a visible effect on an electrometer (constructed on the principle of Peltier); would it be high enough on a house of two stories? If not, what means could I adopt?

Is there any means of making a porous jar that will withstand the effects of nitric acid better than those made of plaster of paris; for that generally falls to pieces after being in action for only a very short time?

I should feel very much obliged to your correspondent J. Cook if he would inform me what is the expense of constructing a coil on the plan he mentioned in your last impression.

Would not the zinc element in the sulphate of copper battery of M. Callaud be attacked and destroyed by the solution.—I am, Sir, yours obediently, J. R. O.

London, Feb. 17th, 1863.

Telegraphic News.

THE UNITED KINGDOM TELEGRAPH COMPANY.

THE General Purposes Committee of the City of London have, upon the application of the Directors of the above Company, granted the Company permission to lay down their wires along Old Broad Street, London Wall, Finsbury Pavement and Place, subject that the work done be to the satisfaction of the City Engineer.

THE ATLANTIC TELEGRAPH COMPANY.

A MEETING of merchants and manufacturers was held last week in the Mayor's parlour at the Council Hall, Sheffield, to hear an address from the Right Hon. James Stuart Wortley, Chairman of the Atlantic Telegraph Company. The meeting was convened by the Mayor at the request of Mr. Wortley, who desired personally to explain to the commercial gentlemen of Sheffield the objects of the Company. In the absence of the Mayor from indisposition, Alderman Vickers, as the Deputy-Mayor, occupied the chair. Among the gentlemen present were V. Corbett, Esq., W. F. Dixon, Esq., J. W. Hawksworth, Esq., Charles Atkinson, Esq., W. Fawcett, Esq., George Wostenholm, Esq., F. T. Mappin, Esq., G. Wilkinson, Esq., J. Nelstrop, Esq., M. Hunter, Jun., Esq., H. Bessemer, Esq., and W. Hargreaves, Esq., &c., &c. After a lengthened and interesting address from the right hon. gentleman, in which he fully explained the causes of the first failure, and the important improvements which have since taken place in the construction of submarine cables, most of the gentlemen then present put down their names as subscribers, the list being headed by the names of the Mayor and Mr. Thomas Jessop. The amount of shares which each would take was left for future decision, it being understood that the secretary of the company who was present with Mr. Wortley, or some other gentleman, would wait upon the principal merchants and manufacturers, to ascertain the number of shares each would take. The proceedings then closed.

THE NEW TELEGRAPH BILL.

THE object of the Bill brought before Parliament by the Board of Trade is to make general regulations in respect to all telegraph companies, existing and future, but not to affect existing companies in respect of a past exercise of powers. Much of the Bill is of general interest and concern. No telegraph above ground is to be placed within ten yards of a dwelling-house worth £20 a year, or across an avenue or approach to such a house, without the consent of the occupier of the house. But a subsequent clause provides that, where the body having the control of a street consents to a telegraph being placed along it, that consent is to be sufficient authority for placing the telegraph along or over any land or building "adjoining to or near the street," but not directly over any building if the owner or occupier objects. Any person in the employment of a telegraph company wilfully or negligently delaying a message, or improperly divulging its purport, is to be liable to a penalty not exceeding £20. Every telegraph is to be open to all persons without favour or precedence, except that messages on Her Majesty's service are to have precedence, if required by any department of the Government. Telegraphs also may be taken possession of for Her Majesty's service if the Secretary of State is of opinion that an emergency has arisen in which it is expedient for the public service that the Government should have control over the transmission of messages; the company to be compensated according to the average profits of the previous three months.

UNITED KINGDOM TELEGRAPH COMPANY.

WE are glad to find that at the meetings held by the friends of the above important undertaking at several of the principal towns in the North of England, a considerable accession of capital has been the result.

Miscellanea.

ONE of the chief features of Glasgow society, and for which that city stands pre-eminent, is the annual re-unions of the various public works, trades, and professions, of the natives of the neighbouring towns and rural districts, and of those who were formerly pupils at the same schools. These social reunions embrace not only workmen and friends, but also their employers and officers, and their good effect in the promotion of a kindly feeling among all ranks is indisputable. We are pleased to notice from the following paragraph, taken from one of the local newspapers, that the telegraph operators in the northern commercial metropolis are not behind their fellow-citizens in aiding what may be termed the cause of social science:—"The Magnetic Telegraph.—On Wednesday evening the 11th, the second annual reunion of the Glasgow employés of this company, and their friends, was held in the Masonic Hall, Garthland Street. The duties of the chair, in the absence of the district superintendent, Edward Tansley, Esq., were ably discharged by Mr. Cawood, the station-master. After an excellent tea, the chairman delivered an address in which he advocated the holding of these social meetings, as tending to promote mutual goodwill; and in reference to telegraphic matters, he remarked on the rapid development of this means of communication. The programme of the concert was then proceeded with, and this exhibited quite an overflow of musical and recitative talent; after which dancing was commenced, and was kept up with great spirit for several hours."

To Correspondents.

ENQUIRER.—Professor Hughes' printing telegraph is extensively used in America, France, and Italy, and may be seen in daily operation at the establishment of the United Kingdom Telegraph Company, Gresham House, Old Broad Street, City.

ONE WHO WISHES TO KNOW.—The twenty miles of india rubber insulated cable, described in page 213 of this journal, was shipped, we believe, from the sheathing works of Mr. W. T. Henley, at North Woolwich, in the month of October last. We have enquired of the manufacturers, Messrs. Wells and Hall, and of Mr. Henley, whether any intelligence has been received of its having arrived at its destination in the Persian Gulf, and are informed that they have not yet received any intelligence respecting the said cable. The insulation tests to which the cable were subjected will be found in page 306 of the second volume of the ELECTRICIAN. The statement that the cable which is now being manufactured for the Persian Gulf will be 25 per cent. superior in its insulation to any hitherto constructed is not supported by anything that has been made public.

L. D. P.—Vols I. and II., can be had bound of the publisher.

M. D.—The TELEGRAPH GUIDE is to be procured at all the telegraph offices, railway stations, and respectable booksellers, &c.

STUDENT.—Ebonite will answer the purpose admirably. We can speak from experience as to its high insulating properties.

JOHN LECHMERE.—No standard "unit" has yet been adopted. The unit of Professor Wheatstone, F.R.S., is described in the Report of the Government Telegraph Committee. It has the advantage of great simplicity in its favour.

ELMA.—A description of the Bonelli telegraph will found in the ELECTRICIAN for 6th June, 1862. The London office is at Gresham House, Old Broad Street, City, E.C.

J. R. O.—We have found the Callaud battery very convenient for experimental purposes; and, by not *overcharging* with sulphate of copper, but supplying this salt in quantity merely sufficient for the work required of the battery, the zinc elements may be protected from the deposition of copper. Mr. Cliff, of the Imperial Potteries, Lambeth, is constructing some of these cells, which can be sold at an extremely cheap rate. On some of the French lines this battery is adopted for signalling, and, we believe, gives satisfaction. By dispensing with the porous cells, great advantage in point of convenience and cheapness is secured. We will answer your other queries on a future occasion.

Notices of several books received have been postponed in consequence of the press of other matter.

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The Electrician.

VOL. III. No. 69.—FEBRUARY 27, 1863.

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GEORGES-SIMON OHM.

MOST of those who have followed the progress of electrical science are familiar with the name, if not with the works, of the celebrated and unfortunate German physicist OHM; but few, probably, have met with any account of his life, or know of the trials and difficulties under which his important investigations were followed. The *éloge* read by Dr. LAMONT, at the Academy of Munich, after the death of Professor OHM, is, perhaps, the only source from which any facts relating to the private life of the illustrious mathematician are to be obtained. M. GAUGAIN has appended to his translation, into the French language, of the "Mathematical Theory of Electric Currents" a short biographical notice taken from the above, from which also we derive the following information:—

GEORGES-SIMON OHM was born at Erlangen, in 1787. His father, WOLFGANG OHM, was by trade a locksmith, and his ancestors, almost from time immemorial, had followed the same calling. WOLFGANG OHM, however, was a man possessed of a taste for severe study, and, though entirely self-taught, had acquired considerable attainments in science, more especially in those branches which were susceptible of receiving any application in his own business. It was his wish, consequently, that his children should receive a certain amount of instruction; and, when they left the *école primaire*, he enabled them to follow a course of instruction at college. At the same time, while he gave them their apprenticeship in trade, he himself instructed them in algebra, geometry, and physical science. Under these circumstances, it is not surprising that the young men, possessed of great aptitude for learning, should have made such rapid progress as to attract the attention of the learned mathematician LANGSDORFF. All honour to this name: through him science received the double benefit of *two* lives devoted to useful and ennobling study!

LANGSDORFF, whom chance had led to notice the young students, declared that upon them had fallen the mantle of the brothers BERNOVILLI, and gave them such encouragement that the father determined to devote them to the career of instruction. So far as the interests of science were concerned, says Dr. LAMONT, this was doubtless a happy resolution; but who shall say that, amid the troubles, privations, and deceptions of his future life, GEORGE-SIMON OHM had not occasion to regret the peaceful existence he might have led in his father's humble workshop? At the age of sixteen we find that he was admitted into the University of Erlangen, which, in a few months, he quitted to enter the Institute of Gottstad, in the canton of Berne; after remaining there for two years and a half, he went to Neutchatel, where, for the same period of time, he was engaged in giving private lessons in mathematics. In 1811 he returned to Erlangen, and was received by the Academy as *professeur agrégé*; this position he occupied but for a short time, being subsequently sent to the Ecole Royale, at Bamberg. In consequence of the dissolution of this establishment, OHM soon found himself without employment; and during the thirteen years which elapsed between 1804 and 1817, he was reduced almost to absolute want, as might be surmised from one or two expressions in the preface of his "Elements of Geometry," published in 1819, but written during this period, where he speaks of *his frozen kettle and empty grate*.

At length, in 1817, he was appointed Professor of Mathematics at the Grand College of Jesuits, at Cologne. Here, for the first time, he had leisure to devote himself to his own studies, and found himself in possession of instruments, by means of which his ideas might be submitted to experimental verification. The manual dexterity he had acquired during his youth was now of the greatest service, enabling him to modify and transform the apparatus at his command; and thus he was enabled to follow all the developments of the system he had conceived, and to discover the relations, until then unknown, which connect the various phenomena of voltaic electricity.

In 1826, we find him at Berlin, occupied with the publication of his "Mathematical Theory," which appeared in the following year. We may give, *in extenso*, the preface to the work:—

"I here offer to the public a theory of galvanic electricity. This is but a special portion of electrical science; but, at a later period, according as I may be allowed by the times, the direction of my mind, and the means at my disposal, I propose successively to publish other similar fragments, which, together, may constitute a whole,—supposing, always, that I find in the publication of this first essay some compensation for the sacrifice it has cost me. The circumstances by which I have hitherto been surrounded have not been of a nature to encourage my enthusiasm for discovery: the indifference of the public threatens to extinguish it; and I have not even been able to obtain a complete knowledge of the works which are analogous to my own. Therefore have I chosen for my first endeavour a ground where concurrence is least to be feared. May the kind reader receive this my work with the same love for the subject matter that inspired the author."

Were it not for the description Dr. LAMONT has given of the character of OHM, we might almost fancy that a hidden but bitter satire of the world and the times was intended in the above. But, though conscious of the importance of the work he had undertaken, and of the general want of appreciation of its true value, OHM was no misanthropist; and, with the amiability and perfect simplicity of his nature, no feeling of resentment appears ever to have mingled. We shall see what cruel disappointments prevented the author from pursuing his researches. Had it been otherwise, the "Mathematical Theory" might have been but the first of a series including all the branches of electrical science.

The "Mathematical theory of the voltaic circuit," which has given to OHM his present reputation, was, at the onset, but a fresh source of misfortune. The *savans* placed at the head of public instruction refused to give him the slighest attention; and, having occasion to present himself at the *ministère*, the author was received in so contemptuous and insulting a manner that, stung to the quick, he declared, under the first impulse of disappointment, that after such a reception it was impossible for him to continue in the position he occupied at Cologne. He was, thus, again, without occupation; and, during the seven years which followed, he led the most precarious existence, deprived of all the necessary means for pursuing his researches.

In 1833, the Bavarian Government relieved OHM from this painful position, by appointing him professor at the *Ecole Polytechnique*, at Nuremburg; but it was not until a much later period that his works began to be appreciated at their true value. It is to the Royal Society of London that the honour belongs of having first recognized their importance. In 1841, this Society awarded to OHM the Copley medal; and the value of the award was further enhanced by the expression of opinion with which it was accompanied. "The Council," it is stated, "awards the Copley medal for the present year to Dr. GEORGES-SIMON OHM, for his researches relating to the laws of electric currents. These researches are contained in various memoirs, which have been inserted in the *Journal de Schweiger*, and

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the *Annales de Poggendorff*, and in a separate work published at Berlin in 1827 under the title *Die Galvanische Keste Mathematische Bearbeitet*. In these works, Dr. OHM, *for the first time*, established the law of the electric circuit, a subject of immense importance, and until then surrounded with the greatest obscurity. He has shown that the vague distinctions established between *tension* and *quantity* are without foundation, and that the explanations founded on these considerations are completely erroneous. He has demonstrated, both by theory and experiment, that the action in a circuit equals the sum of the electro-motive forces divided by the sum of the resistances, and that the effect is always constant while this quotient remains the same."

From this time, the laws of OHM took their place in all works upon physics, and their author became generally looked upon as one of the first physicists in Europe.

About this period the direction of the *Ecole Polytechnique* was given to OHM; and as, at the same time, he occupied the chair of physics, his time was almost exclusively engaged in the duties of his position. He had not, however, renounced the idea of following out the researches which had been interrupted since 1827, and he had even formed the project of establishing a theory which should at once embrace the phenomena of heat, light, electricity, and magnetism. The introductory portion of this work was alone published, under the title of "Documents upon Molecular Physics."

In 1849, OHM was appointed conservator of the collection in physics at Munich; and in 1852 he occupied the chair of physical science at the University of this city. His death took place at the commencement of 1854, from an attack of apoplexy consequent upon the fatigue incurred in the production, within a limited period, of a work on physics which he considered necessary for the instruction of his class.

CONDUCTIVITY AND RESISTANCE.

BY RICHARD LAMING, M.R.C.S.

(Continued from page 181.)

DEFINITION, understood or expressed, is a *sine qua non* in all exact argument, and he reasons in vain who does not begin with it. Fully impressed, long ago, with its necessity, I have, in the pages of this periodical, made it as clear as the plainest words I can command would enable me to do, how the resistance of my system differs from the resistance which Ohm makes to be the converse of conductivity; and I cannot admit, as implied by the Editor, that I have only just now, in my last article, given the public to perceive that the views are in irreconcilable opposition and cannot both be true. I do not presume to take the Editor, "London District," or any other person to task for not reading, comprehending, or remembering what I have written; but, on the other hand, I must object to its being represented that I have not already been explicit on a subject to which I have so often called attention. And I will add that if, as the Editor surmises, "London District," "after propounding a question which necessarily to his mind involved a series of consequences adverse to Mr. Laming's theory," was at all surprised to find it could be "answered in accordance with the results of his own practical experience," he might have avoided the amazement had he only, before putting the question, made himself more fundamentally acquainted with the resources of the new view of electrical action, so far as they had publicly been made known.

I am now invited by the Editor to discuss with him the relative values of Ohm's mathematical system and of the equivalent physical theory. I shall not decline his challenge, though fully sensible of his professional prowess, and duly estimating the support he will derive from a host of other capable engineers, all ardent admirers of the system the deficiencies of which I am undertaking to expose. But there are four things I must stipulate for: steel pens, if we please, but no steel points; fists, of necessity, but never with the gloves off; a struggle for conviction and not for conquest; and last, though not least, a scrupulous exactitude in expression. What I propose to secure for both disputants by the last of these stipulations will be understood by an example:—The editor last week *said* that Mr. Laming's views "and the facts upon which the theory of Ohm is based could not possibly be reconciled." Whereas, what was *meant* could only have been that the views were in irreconcilable opposition to the theory.* To decide that Mr. Laming's views could not possibly be reconciled to "the facts" would have been to prejudge the question at issue, and such an intention will of course be disavowed. I believe that my system will be found to embrace all the facts of electro-telegraphy without exception; and if it does it will explain, not their physical relations only, or proximate causes, which is all the system of Ohm essays to do, but also their originating physical causes, about which Ohm did not profess to occupy himself. Such mistakes as the Editor has made in this instance, although committed inadvertently, inflict a wrong, which it is not always consistent with the due flow of an argument to stop to set right; to escape that horn of a dilemma a controversialist sometimes is obliged to fall upon the second, and put up with an ill it would cost too much to rectify.

It is said that Ohm's formula is now questioned for the hundredth time on grounds of theory. With the previous ninety and nine times, I need not concern myself, and with respect to the present questioning, I remark that the formula, so far as it relates to facts which suggested it, and with which it actually corresponds, remains unquestioned. We need not stop now to ascertain whether they be few or many. What is questioned is that extension of the application of the formula to cases yet untried or to which it only apparently or approximately is adapted, any conclusion about which is itself a theory, and one too, that as it is commonly expounded, is neither built upon, nor conformable, to the common principles of mechanical reasoning, while that which questions it has such an origin, and is so amenable, and therefore must be as a theory the more probable of the two. It will devolve upon me to show that Ohm's formula is being so extended. In the mean time it behoves us to remember how very easy it is to set out from a physical fact and to find ourselves at the first steps floundering in untrue generalities: even in generalizing metaphysical truths we are apt to go wrong if we throw off the restraint of the severest circumspection. If a mathematician were to assure us that because 2 added to 2 come to the same thing as 2 multiplied by 2, therefore addition and multiplication are in effect the same things and may be used indifferently, we should perceive that though he had set out from a truth, he was erroneously generalizing. So if a civil engineer were to say that as certain proportions of a current of water can, under a given pressure, pass through pipes of smaller in connection with those of larger diameters, therefore all other proportions of the stream can pass the smaller as well as the larger pipes, he would be stepping from a fact into an untrue generality. By parity of reasoning, we may be stating a fact while we maintain that a large and a small wire may be equally capable under similar circumstances of conducting in a given time certain small quantities of electricity, though for other larger quantities the one shall be capable and the other not. And if it be so, then in the latter case, as in the two former, a mathematical formula constructed to express a act as far as it goes, must, if applied beyond that limitation, be *a snare and a delusion*. The difficulty is to perceive the limit, and that limit in physical matters nothing can teach us but the true system of physical causation.

The Editor asserts of Ohm's fundamental propositions, "or their complete accordance with every experimental result has been obtained, we, and hundreds of our readers can vouch from experience . . . . We confidently maintain that their practical accuracy cannot be im-

* [If it be necessarily implied by Mr. Laming's theory, as appears to be the case, that "a large conductor with small ends can act no better (in regard to conduction) than another conductor small throughout its entire length," this theory is clearly in opposition not only to the conclusions of Ohm, but to the *facts* upon which these are based.—ED. E.]

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pugned by experiment," which means, of course, that they will prove to be in complete accordance also with every experimental result that shall henceforward be obtained. In due time we shall see whether this assertion can be justified. Next week I will renew the subject, and endeavour to shape out such a course for the argument as I think it may best take so as to be comprehensible by all classes of readers; beginning with a definition of the meanings I shall attach to the terms to be made use of and I will then expect to be furnished with a corresponding series of definitions from the other side.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1849—SOMERVILLE, Mary.—

[On the connection of the Physical Sciences. By Mary Somerville. Eighth Edition. London: John Murray, Albemarle Street, 1849].—12mo, 524 pages.

Sections XXVII. to XXXV., inclusive, on Electricity, &c.

1849—BIRD, Golding.—

[Lectures on Electricity and Galvanism in their Physiological and Therapeutical Relations, delivered at the Roya College of Physicians. Revised and extended. By Golding Bird, A.M., M.D., F.R.S., F.L.S., &c. London: Longman, Brown, Green, and Longmans, Paternosterl Row, 1849].—12mo, 208 pages. Cuts.

1849—HARRIS, Sir W. Snow.—

[Letter to the Right Honourable the Earl of Wilton on the subject of certain returns moved for in the House of Peers, relative to the system of Fixed Metallic Conductors employed in her Majesty's Navy, as a means of protection from Lightning. By Sir W. Snow Harris, F.R.S. July 1849. Plymouth: R. White, Printer and Chart Seller. Parade.]—Pam., 8vo, 35 pages.

1749—NOLLET, l'Abbé—

[Recherches sur les causes particuliers des Phénomènes Electriques et sur les effets nuisibles on avantageux qu'on peut en attendre. Par M. l'Abbé Nollet, de l'Académie Royale des Sciences, de la Société Royale de Londres, de l'Institut de Bologne, et maître de Physique de Monseigneur Le Dauphin. A Paris, Chez les freres Guerin, Rue St Jacques á S. Thomas d'Aquia. MDCCXLIX.] 12mo, 444 pages. Plates.

1850—HARRIS, Sir W. Snow.—

[Rudimentary Magnetism, being a concise exposition of the general principles of Magnetical Science and the purposes to which it has been applied; with 97 illustrations, Parts I and II. By Sir W. Snow Harris, F.R.S. &c., London: John Weale, 59, High Holborn, MDCCCL.] 12mo, 159 pages. Woodcuts.

1850—WALKER, Charles, F.R.S.—

[Electrotype Manipulation, Parts I and II, being the Theory and Plain Instructions in the art of working metals by precipitating them from their solutions through the agency of Galvanic and Voltaic Electricity. By Charles V. Walker, F.R.S. &c., Illustrated with woodcuts. Twenty-third Edition. London: Published by George Knight and Sons, Foster Lane, Cheapside, 1850.]—Pamphlet. Illustrated.

1850—FRANCIS, G.—

[Electrical Experiments, illustrating the Theory, Practice and Application of the Science of Free or Frictional Electricity; containing the methods of making and managing Electrical Apparatus of every description; with numerous illustrative engravings. By G. Francis, F.L.S., &c. &c. Fifth Edition. London: D. Francis, 21 Mile End Road, and G. Berger, Holywell Street, Strand, 1850.]—8vo, 91 pages. Cuts.

1850—ELECTRIC TELEGRAPH COMPANY.—

[Rules and Regulations to be observed by Inspectors and Linemen in the service of the Electric Telegraph Company, Lothbury, January, 1850. London: Printed by Smith and Ebbs, Tower Hill.]—Pam., 12mo, 20 pages.

1850.—RADCLIFF BIRT, William.—

[Report on the Discussion of the Electrical Observations at Kew. By William Radcliff Birt. London: Printed by Richard and John E Taylor, Red Lion Court, Fleet Street, 1850. From the Report of the British Association for the Advancement of Science for 1849.] Pamphlet.

1850.—WALKER, Charles V.—

[Electric Telegraph Manipulation, being the Theory and Plain Instructions in the art of transmitting Signals to distant places, as practised in England, through the combined agency of Electricity and Magnetism. By Charles V. Walker, Superintendent of Telegraphs to the South-Eastern Railway Company, &c. Illustrated by Woodcuts. 3rd thousand. London: Published by George Knight and Sons, Manufacturers of Chemical Apparatus, and Philosophical Instruments, Foster Lane, Cheapside, 1850.]—12mo, 107 pages.

1850—STURGEON, William.—

[Scientific Researches, Experimental and Theoretical, in Electricity, Magnetism, Galvanism, Electro-Magnetism, and Electro-Chemistry. Illustrated with Engravings. By William Sturgeon, Lecturer in Natural and Experimental Philosophy, &c. London: Longman and Co.; E. and F. N. Spon; Willis and Southeran; Bury, Lancashire: F. Crompton.] — Large 4to, 563 pages. Plates

No date to title. Preface dated, 1850.

1851—BREWSTER, Sir David.—

[A popular Treatise on Magnetism, from the seventh edition of the Encyclopædia Britannica. By Sir David Brewster, K.G.H., LL.D., F.R.S., &c. With 107 illustrations. Edinburgh: Adam and Charles Black, North Bridge, Booksellers to Her Majesty for Scotland, 1851.]—Three shillings, 8vo.

1851—LAMING, Richard.—

[Matter and Force; an Analytical and Synthetical Essay on Physical Causation in which the principal phenomena and laws of Chemistry, Electricity, and Heat, are derived mathematically from a uniform volition, and the preservation of the universe demonstrated to be contingent on the incessant exercise of a moral power. By Richard Laming. London: Richard Taylor, Red Lion Court, Fleet Street, 1851.]—8vo.

1851—CHANNING, W. F.—

[Book of the Telegraph. Boston: Published by Daniel Davis, 228, Washington Street. By W. F. Channing, 1851.]—Pam. Illustrated.

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1851—ALEXANDER, William.—

[Plan and Description of the Original Electro-Magnetic Telegraph, with Prefatory Note to the Royal Commissioners of the Exhibition of the Works of Industry of All Nations; and relative documents. By the inventor, William Alexander, Esq., Writer to the Signet of Her Majesty in Scotland, &c.,&c. London: Longman, Brown, Green, and Longmans; Edinburgh: A. C. Black, MDCCCLI.]—Pam. 8vo.

1851—HUNT, Robert.—

[Elementary Physics; an Introduction to the Study of Natural Philosophy, with 217 wood engravings. By Robert Hunt, Professor of Mechanical Science, Government School of Mines, &c. London: Reeve and Benham, Henrietta Street, Covent Garden, 1851.]—1 vol. small 8vo.

From pages 199 to 330 are devoted to Electrical subjects.

1851—ANONYMOUS, Gutta Percha Company.—

[Gutta Percha, its Discovery, History, and Manifold Uses. Illustrated by an engraving in oils and sixty engravings on wood. London: Benjamin L. Green, 62, Paternoster Row, 1851.]—Pam., small 8vo, 48 pages.

Contains, Chapter XI., allusions to first cable between Dover and Grisnez.

1851—KING, William, M. D. Cantab.—

[Magnetoid Currents, their Forces and Directions; with a Description of the Magnetoscope; a Series of Experiments. By J. O. N. Rutter, F.R.A.S. To which is subjoined a Letter, from William King, Esq. M. D. Cantab. London: John W. Parker and Son, West Strand, MDCCCLI.

1851—CHALMERS, Charles.—

[Thoughts on Electricity, with Notes of Experiments. By Charles Chalmers, late of Merchiston Academy. Hydrogen obtained from Water without Oxygen. Oxygen obtained from Water without Hydrogen. Third Edition. Edinburgh: Sutherland and Knox, George Street. London: Simpkin, Marshall, and Co., MDCCCLI.]—8vo, 57 pages. Plates.

1851—SIEMENS, Werner.—

[Mémoire sur la Télégraphie Electrique. Par M. Werner Siemens (de Berlin), ancien officier d'artillerie. Suivi du Rapport fait sur ce mémoire a l'Académie des Sciences de Paris, dans le séance, du 29 Avril, 1850. Berlin: Jul Springer, libraire-editeur, 20 Breikstrasse, 1851.] Pam. 94 pages.

1852—CLARK, Latimer, C.E.

[Electric Telegraph Company: Chart of the Company's Telegraphic System in Great Britain in 1852. By Latimer Clark, Esq., C.E. 448, West Strand.]

1852—BAIN, Alexander.

[A short history of Electric Clocks, with Explanations of their Principles and Mechanism, and instructions for their Management and Regulation. By Alexander Bain, Patentee, to whom was awarded the Exhibition Council Medal, Class X. London: Chapman and Hall, 193, Piccadilly, 1852.] Pamphlet.

1852—WILSON, George.

[Electricity and the Electric Telegraph: together with the chemistry of the stars: an argument touching the stars and their inhabitants. By George Wilson, M.D., F.R.S.E. London: Longman, Brown, Green, and Longmans, 1852.] Small 8vo., 77 pages on Electricity and the Electric Telegraph.

1852—BEETZ, W.

[Uebre Magnetismus. Ein Vortrag gehalten ein missenschaftlichen verein im 13 Märzt, 1852. Von W. Beetz. Berlin: 1852. Druck und Vertag von Georg Reimer.] Pam., 8vo. 28 Pages.

1852—SNOW HARRIS, Sir William.

[A Record of Philosophical Papers and other scientific works. By Sir William Snow Harris, F.R.S., Plymouth: R. White Stevens, Printer and Stationer, Parade.] Pamphlet, no date, probably 1852.

1852—SCORESBY, Rev. William.

[Magnetical Investigations. By William Scoresby, D.D., &c. Vol. II. With illustrations. London: Longman, Brown, Green, and Longmans, Paternoster Row. MDCCCLII.] 8vo. 448 pages, woodcuts.

The first volume was published in 1844.

1852—HIGHTON, Edward, C.E.

[The Electric Telegraph its History and Progress; with numerous illustrations. By Edward Highton, C.E. Assoc. Inst. C. E. London: John Weale, 59, High Holborn. MDCCCLII.] 12mo. 179.

Notices of Books.

CONTRIBUTION TOWARDS A HISTORY OF ELECTRO-METALLURGY. By HENRY DIRKS, C.E. London: E. and F. N. SPON, Bucklersbury.

IN the collection of chronological and other data requisite for the history of various branches and applications of science, Mr. Dirks appears to be as indefatigable, and, perhaps, even as accurate as the late Dr. Hamel, whose valuable contributions in our columns to the history of the electric telegraph will be remembered by many of our readers. Mr. Dirks has undertaken to answer the question, "Who is the *inventor* of the art of Electro-Metallurgy?" Such questions, he observes, are only to be settled by the fact of first publication. Many may have surmised, prior to the first published account of the electro-deposition of metals, applied to useful purposes in the arts, that the crude markings seen on the deposited copper in Daniell's battery might possibly receive a useful application; but if priority of invention had to be settled on such plastic grounds as a man's thoughts or intentions, or remarks in private conversation, the difficulty of settlement in such cases would be almost hopeless, and generally quite impossible. Publication, according to the legal and generally received view, may consist either in public experiment, or actual manufacture or sale: a descriptive account delivered before a scientific society; or a printed statement put into public circulation. In regard to the origin of the art of electro-metallurgy, we find that Professor Jacobi at St. Petersburg, Mr. C. J. Jordan at London, and Mr. T. Spencer at Liverpool, each one unknown to the others, were at the same period of time engaged in investigations upon this subject. In May, 1839, the following paragraph, vaguely referring to the results of Professor Jacobi's experiments, appeared in the *Athenæum*, and was quoted in the *Mechanics' Magazine* and other papers.

"*Galvanic Engraving in Relief.*—While M. Daguerre and Mr. Fox Talbot have been dipping their pencils in the solar spectrum, and astonishing us with their inventions, it appears that Professor Jacobi, at St. Petersburg, has also made a discovery which promises to be of little less importance to the arts. He has found a method—if we understand our informant rightly—of converting any line, however fine,

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engraved on copper, into a relief, by galvanic process. The Emperor of Russia has placed at the Professor's disposal, funds to enable him to perfect his discovery.—*Athenæum.*"

The subsequent facts relating to the invention of the electrotype are thus chronologically arranged by Mr. Dirks.

"9th May, 1839. Mr. T. Spencer wrote a general notice to the Secretary of the Polytechnic Society, that he was engaged in experiments which appeared to accord with those of Jacobi in St. Petersburgh, noticed in the *Athenæum*, which he would take an 'early opportunity of laying before the Society.' See pp. 81, 82.

"22nd May, 1839. Mr. C. J. Jordan *wrote* a letter to the *Mechanics' Magazine*, descriptive of a process for engraving and obtaining casts by galvanism. See pp. 3—6.

"8th June, 1839 (Saturday). The weekly number of the *Mechanics' Magazine* issued, *published* Mr. Jordan's letter, 22nd May, 1839; the earliest published account of electro-metallurgy.

"12th September, 1849. Mr. T. Spencer read before the Liverpool Polytechnic Society, a paper entitled 'An account of some experiments made for the purpose of ascertaining how far voltaic electricity may be usefully applied to the purpose of working in metal.' Pp. 15, 16.

"9th February, 1844. Mr. Spencer wrote a letter, promising "documents from well-known persons, collected in 1841, for insertion in the *Philosophical Magazine;*" Mr. Richard Taylor having granted permission. Not yet published, however. See pp. 25, 26.

"December, 1851. Mr. Spencer resuscitates his claim, based on his letter of May 9, 1839. Pp. 80—96."

The letter of Mr. Jordan, above referred to, will be read with interest.

"SIR—Observing in the last page of a recent number of your *Magazine*, a notice extracted from the *Athenæum*, relative to a discovery of Professor Jacobi, its perusal occasioned the recollection of some experiments performed about the commencement of last summer, with the view of obtaining impressions from engraved copper-plates, by the aid of galvanism, which led me to infer some analogy in principle with those of the Russian Professor, and may probably give me the right to claim priority in its discovery and application. These experiments were abandoned from the want of that most important element in pursuits of this nature—time; the writer's share of the said element being occupied in a manner more imperative than pleasing. I regret, however, not having made it the subject of an earlier communication, as this would have placed my pretensions beyond doubt; but inasmuch as the notice alluded to is given from memory, and is undescriptive, while I may be enabled to exhibit the *modus operandi*, my assertion may be at least partially substantiated.

"It is well known to experimentalists on the chemical action of voltaic electricity, that solutions of several metallic salts are decomposed by its agency, and the metal procured in a free state. Such results are very conspicuous with copper salts, which metal may be obtained from its sulphate (blue vitriol) by simply immersing the poles of a galvanic battery in its solution, the positive wire becoming gradually coated with copper. This phenomenon of metallic reduction is an essential feature in the action of sustaining batteries, the effect, in this case, taking place on more extensive surfaces. But the form of voltaic apparatus which exhibits this result in the most interesting manner, and relates more immediately to the subject of the present communication, may be thus described:—It consists of a glass tube, closed at one extremity with a plug of plaster of paris, and nearly filled with a solution of sulphate of copper; this tube and its contents are immersed in a solution of common salt. A plate of copper is placed in the first solution, and is connected by means of a wire and solder with a zinc plate which dips into the latter. A slow electric action is thus established through the pores of the plaster, which it is not necessary to mention here; the result of which is the precipitation of minutely crystallized copper on the plate of that metal, in a state of greater or less malleability according to the slowness or rapidity with which it is deposited. In some experiments of this nature, on removing the copper thus formed, I remarked that the surface in contact with the plate equalled the latter in smoothness and polish, and mentioned this fact to some individuals of my acquaintance. It occurred to me, therefore, that if the surface of the plate was engraved an impression might be obtained. This was found to be the case, for on detaching the precipitated metal, the most delicate and superficial markings from the fine particles of powder used in polishing, to the deeper touches of a needle or graver, exhibited their correspondent impressions in relief with great fidelity. It is, therefore, evident, that this principle will admit of improvement, and that casts and moulds may be obtained from any form of copper.

"This rendered it probable that impressions may be obtained from those other metals having an electro-negative relation to the zinc plate of the battery. With this view a common printing type was substituted for the copperplate, and treated in the same manner. This, when removed, was found to be a perfect matrix, and might be employed for the purpose of casting, where time is not an object.

"It appears, therefore, that this discovery may be turned to some practical account. It may be taken advantage of in procuring casts from various metals, as above alluded to; for instance, a copper die may be formed from a cast of a coin or medal, in silver, type metal, or lead, &c., which may be employed for striking impressions in soft metals, casts may probably be obtained from a plaster surface surrounding a plate of copper; tubs (tubes?) or any small vessel may also be made by precipitating the metal around a wire, or any kind of surface, to form the interior, which may be removed mechanically, by the aid of an acid solvent, or by heat.

"C. J. JORDAN.

"May 22, 1839."

The conclusion arrived at, which cannot fail to be generally endorsed, is, that Professor Daniell is the *discoverer* of the principle on which the deposition of compact copper depends; that Mr. C. J. Jordan is the *inventor* of the first application of that principle to useful purposes in the arts, known as electro-metallurgy; and that Mr. T. Spencer is the first of the class of *improvers* in the art so invented.

MR. T. WEBSTER'S PAPER ON THE SUBMARINE TELEGRAPH.

DISCUSSION AT THE SOCIETY OF ARTS, FEBRUARY 11, 1863.

THE CHAIRMAN said, before the discussion commenced it might be well that he should place before them the exact position in which the question stood. They would recollect that a paper on this subject was read by Mr. Masey a fortnight ago, and in consequence of the great interest of the subject, and the great number of gentlemen who wished to speak upon it, it was understood that the discussion should be resumed as soon as the Council could find a fitting opportunity. By the kindness of the gentleman whose name had been put down to give a paper this evening they had been able to arrange for a renewal of the subject on which Mr. Webster had just read his paper by way of introduction. On the last occasion the discussion was chiefly directed to the mode of laying down the cable—he hoped this evening it would turn more upon other points. He begged to call upon Mr. Jenkin to open the discussion.

Mr. FLEEMING JENKIN was very glad to hear from the Chairman that it was thought advisable that the discussion should embrace other topics than those which were touched upon at the last meeting. He thought it was necessary that some of the points adverted to in the paper of Mr. Masey, and in the subsequent discussion, should be treated by those who had had practical experience in these matters, which he (Mr. Jenkin) might lay some claim to. First, he would to the statement of Mr. Masey with regard to the arrest of the chemical action in cables laid at great depth in the sea, and their non-liability to decay. Upon that question he would say that experience showed them that they could not hope for quite such a favourite result. The almost total decay of the iron-wire covering was the cause of the failure of an attempt to repair a cable on which he (Mr. Jenkin) was engaged in the Mediterranean, and the wire at the depth of 1,200 fathoms was very much decayed, showing that oxidation of the metal had taken place at that great depth. He might add that on the same occasion he obtained evidence in corroboration of what Dr. Wallich had stated as to the existence of living animals at that great depth, which could not be the case unless chemical action was carried on. He had brought with him some of the eggs of a species of cephalopod; these were attached to a cable raised from depths of between 700 and 1,200 fathoms, and when the eggs were opened the embyro fish lived for a short time. That being the case, he was afraid they could not count upon any of the materials which were not permanent in shallow water being permanent in deep water; and, therefore, if iron wire were used for the cable, it must be protected against oxidation: if not, the cable would probably in time break up into short lengths. Reference was made at the former meeting to the spiral form of the wire covering. It was an almost universally received opinion on the part of the public that the spiral covering allowed the cable to stretch so as to injure the interior core, to a very great extent, as compared to what would be the case with a solid rod of iron. Now, considering it had been the universal practice

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of telegraph engineers ever since these cables were made—at any rate for shallow water, and in a great many instances for deep water—to use the spiral form of protection, he thought some doubt should have arisen in the minds of those who advanced that statement, and it would have been well if they had tested their theoretical conclusions by actual experiment. He would refer on this point to the experiments which were printed in the Blue Book of the evidence received by the Board of Trade Committee, from which they would find that whereas half the breaking strain of a single wire caused an extension of from 0·15 to 0·18 per cent., a cable covered with these spiral wires was extended 0·3 per cent. with half its breaking strain, and that the breaking strain of a single wire caused an extension of from 0·4 to 0·5 per cent.; while the breaking strain of the cable caused an extension of 0·7 to 0·85 per cent., so that really there was no material difference between the two. The cable stretched only a small fractional per centage more than the solid wire would do, and that was not mere theory, but had been proved hundreds of times by himself. The reason for this would be very apparent, when they looked at the matter a little more closely. If they took a single wire in the shape of a corkscrew it would elongate with a very small strain, because its diameter could diminish without experiencing any very sensible resistance; but when they put a series of corkscrews round a cable so that one butted against the other, the diameter of every one of those corkscrews could not diminish because they formed a complete arch of solid wire all round the cable. In order to diminish the arch, they must squeeze each wire flat, or at least oval, and the consequence was that the spiral covered cable, as regarded extension, acted almost like a solid rod. The form in which it was disposed presented a great resistance to pressure. The arched form of the wires prevented pressure coming upon the soft gutta-percha and hemp of the core, whether from longitudinal or casual strain, and made the most perfect protection against external injury which, in his opinion had ever been devised. Nevertheless, he believed the interruption to the Atlantic cable had been ascribed to the proper causes, viz., the slight extension of the cable, and the separation and reclosing of the copper wires. The slight extension, though only a mere fractional part of the total length, would be sufficient to separate the copper wires if they had been previously broken, and to allow them to come into contact again, when the strain was removed. It was well known that some joints had been carelessly made, and probably the failure occurred at one of these. He thought that was not likely to occur again. The copper wire was in seven parts, and had been carefully tested and inspected, but if, as was now most improbable, some break did exist through all the copper wires at one point, the same result of separating the wires at this break and allowing them to close after the strain was removed, would occur even if they had a solid steel tube round the cable; indeed, the solid steel tube would stretch more before it broke than the spiral cross covering, although it would bear a greater strain. He might mention that cables had been picked up from a depth of 1,500 fathoms and the gutta-percha was found to be uninjured, and the iron wire not disturbed nor the diameter distended. The whole thing had been brought up in the same state as when it went down; therefore, to suppose that there was any practical objection to the spiral form of covering was, in his opinion, a fallacy, as had been shown by the many specimens which had come under his personal attention. Not only was the outer covering of the cable recovered from great depths free from defects, but the gutta-percha insulator was uninjured in the way which was stated on the last occasion. One speaker went so far as to assert that a pressure of two or three tons per square inch upon the gutta-percha for a few hours, caused it to absorb so much water that insulation was destroyed. There was not the slighest foundation for such an assertion. He had the strongest proofs to the contrary in the condition of the gutta-percha in cables he had picked up, after it had been submerged in great depths for three years. The insulation of the wire was perfect while at the bottom of the sea, and when it was picked up, the gutta-percha itself was as good as on the day on which it was sent out of the manufactory. The same fact was daily confirmed by the application of artificial pressure. To give them some idea of the perfection to which insulation by gutta-percha had been brought, he would state this fact. If 2,000 knots of a cable similar to the Malta and Alexandria cable were taken for the Atlantic, and the core maintained at 60 deg. temperature, out of every 100 parts of electrical current that was started, 97·85 would arrive at the further end of the 2,000 nautical miles of cable, which showed a loss of electricity of only a little more than 2 per cent. Under these conditions, in conformity with electrical laws, which he need not enter into, more current started than if the cable were absolutely perfectly insulated, so that if they compared the current (with a given leakage) which would arrive in America through such a cable as the Malta and Alexandria with that which would arrive through a cable with absolutely perfect insulation, the difference would only be 0·7 per cent. instead of 2·0 per cent., showing clearly that any further improvement in the insulating material was not required, and even if kept at a heat of 75 deg. Fahr., the difference would be inconsiderable. In the case of the old Red Sea cable, at 75 deg., 62 per cent. of the entering current would arrive at the end of 2,000 knots. These were not theoretical calculations, but were results which he had confirmed by actual experiment, when lengths as great as 2,000 knots were at his command, and he would add that it was well known that pressure improved, instead of deteriorating, the insulation by a small per-centage. With reference to the retardation of the signals, mention had been made of a limit in point of distance, beyond which it was suggested they might not be able to transmit signals. He would say there was no such limit, If they had a cable to the moon they could send signals through it; but through any one cable of given length and dimensions there was a limit to the number of distinct currents, and consequently to the number of distinct signals which could be sent through that cable, and that limit was, as Mr. Webster had stated, inversely as the square of the distance, and, therefore, *cæteris paribus*, short spans were desirable. Where a given ratio between the copper wire and the gutta-percha was kept to, the number of words that could be sent per minute through any one length with any core was simply proportional to the quantity of materials used; so that, as it were, they got so many letters per pound of material employed. If they wanted ten words per minute, they must use twice as much material, both copper and gutta-percha, as if they required to transmit five words per minute. The actual speed in words through every given length of cable was a matter on which all electricians differed a little—not as to the electrical laws themselves but from the employment of instruments more or less efficient; but he was certain that a speed of transmission through 2,000 knots of cable could be obtained, which, if the cable were permanent, would return an excellent dividend for the outlay. With reference to light and heavy cables, the curves assumed by the cable while being laid, the strains which came upon every part of it, the strain which was necessary to lay it taut, and the loss which was sustained if it were laid with less strain—all these points were very ably treated in a paper by Messrs. Brooks and Longridge, read about three years ago before the Institution of Civil Engineers. The conclusion at which those gentlemen arrived upon theoretical grounds he had proved in practice to be correct. Their mathematical investigation was singularly complete and perfect, and he was surprised that very able paper had not been more often alluded to. The case against heavy iron cables, such as he had heard were proposed for the Atlantic company, was this, that in order to lay the cable along the bottom of the ocean without any very great loss, they must put on a strain in paying it out which was equal to the weight of the cable hanging vertically from the side of the ship to the bottom of the sea, and in order to pay out the cable taut, such a strain was required, that for every thousand fathoms approximately they must put on a quarter of the breaking strain; so that in 2,000 fathoms they would have half the breaking strain; and if they diminished that strain only a very little, they lost a great deal of cable; so they had what engineers called a co-efficient of safety of only 2; and with a cable of great specific gravity they had the disadvantage that if they did not put on the full strain necessary to lay the cable taut at the bottom, they very rapidly lost a large per centage of the cable; so that with a cable of the specific gravity of the old Atlantic cable, payed out in a depth of 2,000 fathoms, at the rate of 4¾ knots an hour, they lost 25 per cent. of cable if the strain were 3 per cent. too small, and 50 per cent. if the strain were 10 per cent. too small, according to Messrs. Brook and Longridge's tables. Now, with a cable of light specific gravity, even if it were of the same absolute weight and strength, they might diminish the strain 20 per cent. before they lost 25 per cent. of the cable, at the same speed; and if they went faster—say seven knots per hour—they might diminish the strain 70 per cent. before they lost 25 per cent. of cable. That to his mind was the real argument in favour of light cables. The great difficulty was to get a cable which should remain permanent when laid. He had no doubt before long the problem of a permanent cable in deep water would be solved. There were some other points which he might refer to, but he thought he had already occupied as much of the time of the meeting as he had any right to do.

Mr. THOMAS ALLAN remarked that the first question to be decided in establishing a telegraphic communication between Great Britain and America was as to the cable itself; the route by which it should be laid was a matter which could be determined hereafter. What they wanted was, in the first instance, a cable that would meet the requirements of the case, suitable for being submerged in ocean depths without injury to its electric conductability. It was quite evident, as the result of all experience, that the cables hitherto constructed were

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only suitable for shallow waters, and not for ocean depths. What they required was a cable of light specific gravity, and that the combination of materials should be such that, in the laying, there should be no injury to its working condition; also, that its bulk and weight should be such, that in case of necessity they might be able to recover long lengths of the cable. They knew that in the case of the Atlantic cable, with its comparatively small bulk and weight, it almost swamped the *Agamemnon*. In order to encourage them in this matter, there had been given, on a former occasion, a long list of cables successfully laid; but he had not seen a list of the failures. Cases were multiplied of the submerging of cables in shallow waters; but there was only one in existence which was really in ocean depths, and that only for a short distance, and within the last few weeks it had been found that that cable had followed the fate of its predecessors, which was an additional evidence of the inapplicability of those cables for such purposes. It broke in submerging; it was picked up and repaired; and that fact was sufficient to prove that there were errors in the principle of construction. The successes were certainly very great successes, much greater than could have been expected, because from the way in which the cables were constructed, they might have expected failure rather than success, and he looked upon them as "happy go lucky" successes. They must go to the great failure of the Atlantic cable to guide them for the future. Its unsuitability in point of conductive power was not the main question, which was simply a mechanical one—the doubt was, whether such a cable could ever be submerged to that great depth without destruction to its internal or electrical portion. On the last occasion they were told that the cable would never have spoken at all but for the ingenuity of the instruments prepared for the purpose, and that the signals were so slight that they could scarcely be recorded at the other end. It was clear to him that any other cable constructed on the same principles would equally fail in accomplishing the object sought. He had been informed that the new Atlantic cable was intended to be of extra weight and strength, but in proportion to the extra weight were the chances of elongation of the cable, and a similar destruction of the core to that which occurred in the former case. At the time the Atlantic cable was laid, he predicted that it would not work after it was submerged, and the *Times* expressed its opinion that although it might work temporarily, it would not answer permanently, from the principle on which it was constructed. Mr. Allan proceeded to describe the principles on which he had constructed a cable, in which the strength was placed where he contended it was most required—viz., in the centre, the outer covering being of light specific gravity. Upon that principle he contended that the electrical condition of the cable was best maintained, and by that means the probabilities of a permanent communication were greatly enhanced.

Mr. WALTER HANCOCK said that, in conjunction with his father, he had devoted to the manufacture of gutta percha the nineteen years since its introduction into this country, and he would make a few remarks upon the important relationship in which gutta percha stood to the science of submarine telegraphy, in its present crisis, and in its probable future. He would refer especially to matters of immense importance that had not had their due weight with electrical engineers when designing cables. It was notorious that they had committed great errors, which had resulted in costly failures. In round numbers, 10,000 miles of lost cable, worth £2,000,000 sterling, were lying at the bottom of the sea, and the startling fact that that portion of the resources of the country, instead of remaining in our hands in a productive form was lost to us for ever, confronted us, at once a monument of our past ignorance, and a beacon for our future guidance. Had we fully profited by the experience of the past? He feared not. The following vital points were still unsettled:—1st. The size, form, and construction of the conductors. 2nd. The insulating material we ought to adopt, and the quantity we ought to employ. 3rd. The form, nature, and specific gravity of the material to be used as an external protection. 4th. The all-important question of the just relation and proportion that should exist between these three essentials, conductor, insulator, and protector, in order to adapt them to particular situations, and particular depths. These questions, too often solved hitherto by predilection for some one particular theory, must in future be decided by the unerring oracle of scientific truth. It behoved us at this crisis in submarine telegraphy to take a comprehensive survey of the stupendousness of the work to be accomplished, and the comparative scantiness of the means that Providence had at present placed in our hands for its accomplishment. The work was nothing less than to establish the supremacy, the universal empire, of telegraphy over the entire globe. It was generally acknowledged that if we had at this moment 20 cables to America, 20 to Gibraltar, Malta, and Alexandria, and from thence 10 to India, 5 to China, and 5 to Australia (and these would require about 200,000 miles of insulated wire), we could make constant use of the whole, provided only that they were economically constructed and worked, so that the tariff for messages might be moderate. He thought we could not afford to postpone for fifty years, or possibly for a century, the completion of these lines that were required for our service of to-day. But that this would be the inevitable consequence of pursuing the course that had been hitherto adopted was not a mere assertion, but a fact, demonstrable by the following statistics:—The average importation of raw gutta percha for the last ten years had been 750 tons per annum, and it was only maintainable at this rate by a gradual advance in price from 1s. to 2s. 3d. per pound. But of this quantity, 300 or 400 tons only were of a quality sufficiently good for telegraphic purposes; an increase to 500 tons might be possible, with extraordinary exertions and a further advance in price. Now, if it were necessary that the cables referred to should be heavily insulated, for instance, with 550 lbs. of gutta percha per mile, as it was to be feared that the Atlantic Telegraph Company (so far as they had given any indication of their views), would probably decide upon, should they be successful in raising the £600,000 they asked for, it would be obvious that the 200,000 miles referred to would require 50,000 tons of gutta percha, and that it would require 100 years' supply, at the 500 tons per annum, to produce this quantity. Or if we covered one-half of our cables with india rubber, it would occupy fifty years. Unfortunately the supply of india rubber stood in the same predicament; the average annual imports of the best, or Para, india rubber being about 1,000 to 1,200 tons, nearly the whole of which was absorbed in the ordinary india rubber manufactures of the country. These facts spoke eloquently to us all; they told the manufacturers of gutta percha and india rubber that they must economise the expenditure, and increase the efficiency of their materials; they told the electrician that he must direct his attention to reducing the size of his conductor, so that the economy of insulating material may be fully carried out. It was lamentable to see the material that had lavished upon the Malta-Alexandria cable; he believed that fully one-half of it might for that line have been advantageously saved. An opinion prevailed, and he believed it to be well-founded, that it was not necessary to expend £600,000 in the construction and laying of a cable across the Atlantic. He considered that a good serviceable cable could be laid for £250,000, and that that amount might ultimately be reduced within £150,000 or £180,000. The necessity for economizing the gutta percha was not a recently-formed opinion; his evidence in the Blue Book, published by the Government Committee appointed by the Board of Trade, would show that this subject had long engaged his attention. In proof that this economy was practicable, he stated that he insulated a wire with 105 lbs. of gutta percha with four coats, and that upon repeated testings, side by side, after twelve months' submersion, it was absolutely identical both in its insulating power, and in the smallness of its induction, with the wire so often referred to in the Blue Book, as the twenty-coat sample, which was insulated with 330 lbs. of gutta percha. This sample cost £100 to £120 per mile, while his sample would cost £20 only. Referring briefly to the moot point of the value of intermediate compounds, and specially to that one known by the name of Chatterton's compound, he stated that too much reliance should not be placed upon them, because it was evident, from the rationale of their operation, that they improved insulation in inverse proportion to the otherwise defective state of the work upon which they were employed; and because they rendered the gutta percha upon which they were employed more susceptible to the injurious effects of heat, either in warm climates, or in the hold of a ship. With regard to cables for deep seas, he believed that we should ultimately come round to the adoption of hemp, the cause of which had been for many years very ably advocated by Captain Rowett. Those who advocated iron, opposed hemp on the ground that it would perish; but what was their practise? In Mr. Masey's paper it was stated, "It is now acknowledged by all connected with the science that the outside wire should be protected from corrosion by hemp and other substances." Now, if hemp were not able to take care of itself, how could it permanently protect the iron? The cables of the *Royal George*, after fifty years' submersion, came up sound. The alleged tendency to decay might, in all probability, be arrested or prevented by a preservative solution. It would probably long survive any iron cable, and if it should ultimately perish he did not consider it of any great importance, because, for seas of extreme depth, he regarded an external cable as necessary principally to protect the core until it reached the bottom, and that, if the core once reached such a depth safely, and maintained its electrical efficiency for one month without diminution or variation,

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he believed that that core would remain safe and reliable until the cable had paid for itself. In conclusion, he would express unbounded confidence in the future of submarine telegraphy. Our failures had arisen from causes that were remediable; we must avoid them in future—renounce the predilection for any particular theory, economise our resources, and enlist the sympathy and co-operation of all who were willing to advance the cause. Then, and not till then, the triumph of submarine telegraphy would be assured. The wonders that it had achieved, and was daily achieving, foretold the certainty of its triumph. Already it furnished in our morning journals the record of what had passed in all the capitals of Europe in the previous day; the day would come when, outstripping the sun, it would also record in the morning, not what the Emperor of China, or the Tycoon of Japan, proposed to do, but that which he had done in the afternoon.

Dr. Collyer said he was in the United States in 1857, and having then seen the nature of the telegraph the company were about to lay down, he wrote to them a letter, an extract from the reply to which he would read. He did so, he said, in order to show that he was not exactly a novice in the matter now under discussion. He had not only made experiments in telegraphy on a large scale, but he had been associated with gentlemen largely connected with the subject. The great point was to have a good conductor and a good insulator, and that the induction caused by the external wire now used to protect the conductor should be reduced as much as possible. In 1857 he proposed to the Atlantic Telegraph Company that a large core made of copper (a good conductor), say a quarter of an inch in diameter, should be employed, and that the strength of the cable should be in the centre. He believed that mechanically, as well as electrically, if that suggestion were looked at without prejudice, it would be found to be right, and that the proper place for the strength of the cable was in the centre. If the strength were external and not internal, there would be a breaking of the internal structure. At that time gutta percha, not having been brought to such a state of purity as at present, was a great source of leakage, as far as the insulation was concerned. He proposed a large conductor of copper; and not a very large proportion of gutta percha covering. One word with regard to the aurora borealis. In conversation with Dr. King, who went in search of Captain Franklin, he was told that the aurora was merely the effect of magnetic disturbances, not the cause, and therefore the objection that was raised, that the aurora would cause a disturbance in the cable, had no weight.

Mr. Cromwell F. Varley wished to correct a few erroneous notions which had got afloat. The first was as to the condition of the old Atlantic cable before it was laid. That cable during its manufacture was injured, to a great extent, by exposure to the sun. So much did it get heated at one of the manufactories, that the gutta percha was found oozing out through the external covering. All those portions that showed signs of imperfection were then cut out; but, necessarily, the eye could not detect all the places that were injured, and when that cable was put on board ship, and taken to sea, and then, not being laid, was taken to Keyham, and put into a tank, it underwent many operations of testing and cutting out the defective parts, and he was told that many of the parts had not been put together carefully. More than that, recently he had seen many parts of that cable in which there were nothing more than bell-hangers' joints covered over with gutta percha. He (Mr. Varley) had made some inquiries from Professor Thompson as to the state of the cable before it was laid, and he had gathered from that gentleman's memoranda that a serious fault had been shown to exist not many miles from the end that was landed on the Irish coast. When the cable was made, it was not put under water; it was never placed in the element in which it was to operate until it was actually submerged. Consequently any defect in it could not at first show itself. Still defects manifested themselves in the cable. Although it was dry, defects showed themselves sufficiently to account for the non-success of the cable when laid. As to the thickness of the insulating material necessary for a deep sea, he believed it was very small. A piece of wire merely covered with gutta percha had been tested in the usual manner with 500 cells of Daniell's battery, and it resisted the action for a very considerable period—in fact, it did not break down at all. He had frequently submitted gutta percha of the thickness of a thousandth of an inch to the same test, and successfully, for above twenty minutes. Sheet gutta percha, when made ten years ago, was comparatively opaque and porous, looking almost like calico, whilst now it was impermeable and transparent. Still there was a certain amount of porosity which required to be guarded against, and this could be done by covering the wire first with a layer of gutta percha, then with a non-conducting, soft, adhesive material, such as that known as Chatterton's compound, and then again with a layer of gutta percha, which would thus adhere to the first, and, by repeating this process, the defects in the insulation could be reduced to a minimum. It was stated that a cable thus covered had failed, but this was not the case, for a man on board the ship had been bribed to drive a nail into the rope, which, of course, destroyed it. It might be true, as Mr. Hancock had stated, that when the wires covered with Chatterton's compound were tested before being laid, against those covered simply with gutta percha, the decision was in favour of the wire on which Chatterton's invention was not used. At the lower temperature, however, of the bottom of the sea, the decision was just the reverse. Last year he laid down a new wire covered with Chatterton's compound, and the insulating power of these wires was considerably greater than that of those not so treated. He would not enter into the dispute between gutta percha and india rubber. Gutta percha had done good service, and experience did not warrant a change in the material to be employed. The insulation secured by the gutta percha was more than sufficient for the transmission of messages across the Atlantic, and he, therefore, rested content with that material. To hear the observations which were constantly made, one would suppose that the Atlantic Telegraph Company desired to work in the most blundering way possible. This was not the case. The Atlantic Telegraph Company, during the lifetime of Robert Stephenson, had his name attached to their enterprise. Mr. Fairbairn was also among them, and he was sure he need not mention other names to warrant the assertion that the highest talent had been secured to assist the company. A great deal had been said about the cable which the Atlantic Telegraph Company were going to lay, and although he must pay Mr. Jenkin the compliment of saying that he agreed with him in almost everything he had said, he, in speaking of the cable which the Atlantic Company was going to lay, had really gone beyond his knowledge, as no decision had been come to as to the kind of cable to be used.

Mr. Jenkin said he had spoken of the old cable, or had meant to do so.

Mr. Varley would say no more on that point. When the Sardinia and Bona submarine cable had been maliciously injured, and the wires were taken up, it was found that the insulation at the depth of 1,600 fathoms, after five years' wear, was perfect. It was true that the Algiers telegraph was out of order, but that was not in deep water, but near the shore. The cable from Spezzia to Corsica, laid in 1854, was at this moment in perfect working order, and had never cost a farthing for repairs. It had been said that tension of the wire spoiled insulation. Now he had frequently had to deal with wires that had been very considerably stretched, and he remembered that when a portion of the Metropolitan Railway gave way between King's-cross and Euston-square, the telegraphic wires went down several feet without destroying the insulation, although it was afterwards ascertained that the tension had been so great that it was necessary to cut out four or five yards of the wire.

Mr. Huxley said there was a point of view in which the question must be considered, but which was escaping the notice of the meeting. Although a great deal of learning had been displayed as to insulation and induction, the great question in the mind of the public was the expense. To him three points, three principles, seemed to be settled—one, that a cable should have perfect insulation; next, that the outer covering should not be subject to injuries from external sources; and, thirdly, that the cable should be flexible, without liability to be broken or kinked. The issue came to this:—whether metallic coverings were proper for the purpose. Whether they could be made so light as to fulfil the necessary conditions was questionable; if that could be done then one difficulty was solved, and this would go further, in his opinion, to settle the matter than anything else. It seemed, however, to many, that iron or steel coverings would not satisfactorily fulfil the conditions. There were exquisite specimens on the table of that covering, and of other coverings, but he thought they should consider whether it could not be proved that iron was not suited to the purpose. On the table there was a specimen of an exceedingly light cable, covered with rattan cane. It could be made of any degree of weight necessary to submerge it, and it appeared that the covering of silex was absolutely impervious to the sea, impervious to insects, and would wear for any length of time. He thought this, then, fulfilled many of the requisite conditions. It did not heat under any circumstances, and its indestructibility was familiar to us all.

The Right Hon. J. Stuart Wortley desired to tender his thanks to the Council of the Society for their courtesy in permitting him to be present, and to take part in this interesting discussion. But he was perfectly conscious that that courtesy had been extended to him, not on any personal ground, but on the ground of his position as chairman of the Atlantic Telegraph Company. At the time of its

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failure, he had no connection with that Company beyond the embarkation in it of a moderate amount of capital, to which he was tempted by the grandeur and the great prospects of the undertaking, not in a commercial sense, but in a national and general sense, as one of the greatest undertakings conceived by the mind of man. His object in presenting himself was to remove misconceptions, and the principal error he wished to correct was this:—It had been stated that the Atlantic Telegraph Company had determined to do this, and had settled to do that. Now he might, as chairman of that Company, expose himself to ridicule, if he said they had settled nothing; still he was prepared to believe that, in taking that course, they had taken a truly scientific and wise course. Hitherto they had been without sufficient information. Numerous experiments had been made, by which a great deal of light had been thrown on the subject, and he took some little credit on himself for having suggested to the Government the appointment of a commission, and having suggested to that commission the taking of evidence by word of mouth instead of by written papers, the consequence of which had been the collection of an amount of information which, if properly used, would be productive of immense benefit. This information had not only been circulated in England, but in France, for he had seen in the *Revue des Deux Mondes* an article in which the contents of the Telegraph Blue-Book were fairly and fearlessly discussed, and it was admitted that a great step had been taken in the science of submarine telegraphy; and while credit was given to the company for being the first to imagine the possibility of achieving their great work, the *Revue* went on generously to say, the faults were not theirs, for that in those times they had not the lights which had since been obtained. One gentleman had spoken of the cable the Atlantic Telegraph Company was going to lay. It turned out that he meant to refer only to that which they had laid. But then, why speak of a cable of heavy iron, that could not support itself? Another gentleman spoke of the immense quantity of gutta percha the Company were going to waste, by throwing it to the bottom of the Atlantic, but he would ask where they learned either the form of the cable the Atlantic Company were going to lay down, or the amount of gutta percha they were going to send to the bottom of the sea? The fact was, the Company had decided nothing. They had obtained the best information, they were making experiment after experiment, but till the result of those experiments had been submitted to the judgment of scientific and practical men, and their opinion had been obtained, the Company would not decide what should be the form of the cable, or what would be the substance of which it would be composed. The Company had obtained the assistance of Mr. Fairbairn, upon whom the mantle of the two Stephensons seemed to have descended; of Professor Wheatstone, avowedly at the head of electric science in this country; of Professor Thompson, of Glasgow, and, in their own service, of Mr. Varley, who had addressed the meeting to-night. These gentlemen would investigate the various schemes, and the prospects which they held out, and when they had formed their judgment, the Company would carefully weigh their recommendations. It had been represented that the Company had entered into a contract with a monopolizing firm, and had bound themselves hand and foot. But this was altogether untrue. The Company were free to make contracts with any one. They were bound to no form of cable, to no mode of manipulation. Whatever its faults, the Company had not rushed into the enterprise without due deliberation. They had kept their hands free from prejudice, and from all commercial and other restrictions. Allusions had been made to the failure on a former occasion. Mr. Varley had, he thought, sufficiently accounted for that; but it was well known that, so far from that failure being a matter of astonishment, it was a miracle, indeed, that the cable ever spoke at all. Those who projected it knew little of the subject; those who manufactured it were without experience; there was not time for the work; the manufacturers of the two portions failed in making the twist in both in the same direction. A high authority, who saw the cable at Liverpool before it was shipped, pronounced it impossible that it could ever be of any use. They were, however, far from being discouraged by their first failure. The *Revue des Deux Mondes* allowed that the Atlantic cable had failed, but it added that it had established the fact that the electric current could be transmitted through long lengths, and that the failure was wholly owing to surmountable difficulties. In point of fact, he believed the general opinion to be, that so far from deep water being an impediment, or a source of failure, the deeper the water the safer would be the cable, and the farther removed from accident. The greater number of failures of electric cables had, in fact, been in shallow water. It had been said that there was only one telegraph at work in deep water, and the Algiers cable, in 1,600 fathoms, was referred to, but the cable communicating between Toulon and Minorca, which included deep water, was perfect at that moment. The Company were anxious to obtain all the information in their power before again attempting so great an enterprise.

Mr. HANCOCK expressed his pleasure at hearing that the Company were not bound to any particular form of wire, or to any particular mode of insulation.

Mr. JENKIN explained that he might have been in error in using the term "new Atlantic cable," but his calculations were all based on numbers from Brook and Longridge's paper on the old Atlantic cable.

Mr. C. W. SIEMENS was of opinion that discussions like these did a great deal to spread a perfect knowledge of matters connected with so vast an undertaking as the Atlantic cable. There was no doubt that a light cable could be made to speak. It was a question for the shareholders how quick they wished it to speak, and then it was a question what quantity of material could speak the best. With regard to the outer coating of the cable, he thought that most important. Electricians knew pretty well what could be done with a given material, and there might be different plans of putting it on. Some might be in favour of one material and some of another: and they knew that with a given quantity of gutta-percha or india-rubber they could obtain insulation, but in deep sea cables the quantity of outer covering was of great consequence. It was most generally admitted that a heavy cable was not suited for deep waters: and it was also admitted that a sheathing of some sort was necessary in order to protect the insulated conductor, not only in trans-shipment and paying out the cable, but afterwards in protecting it against the inroads of marine animals, or the accidental strains to which it might be exposed in lying on a rough bottom. As to what the best form of covering might be, he supposed the meeting would not agree, because, like most problems, after it had been plainly stated it might be solved in various ways, and most of those who were professionally engaged in those matters would form a rather strong opinion in favour of one form or another. But in meetings like this opinions were brought together, and he hoped to see the great enterprise of the Atlantic cable accomplished by one or various modes. He thought there was plenty of room for two Atlantic cables at least, probably for more. Before he sat down he would only remark that there seemed to be much misapprehension respecting the effects of earth currents upon the working of submarine telegraphs. It would appear, from Mr. Varley's observations on the former occasion, that the disturbing influence of these currents was very great, whereas, in point of fact, they were of no practical importance. The earth was no doubt a powerful magnet, as was proved by the appearance of the magnetic light at the polar surfaces, but no current would result from the terrestrial magnetism, except at the time of any change occuring in its intensity, and it was well known that these changes took place only very gradually. In making the necessary arrangements for the working of the Malta and Alexandria line, he had made no provision against earth currents, and the fact that the battery power in working this line had been limited to eight cells was the best proof that no such provision was necessary.

Mr. T. A. MASEY wished to say a very few words with reference to what had fallen from Mr. Jenkin relative to the strength of the outer covering of cables. The shore ends of the Dieppe cable formed a perfect cylinder, and were capable of bearing almost any pressure that could be brought upon them. In the shipping of that cable at the East India Docks, it was carried across the roadway, and one of Pickford's vans, heavily loaded with pig iron, passed over it, scarcely making an indentation in it. With regard to the Atlantic cable, he held in his hand a specimen which had been laid in about 2,000 fathoms, and it was found that although the wire covering had been strained to such an extent as to lay bare the gutta percha, yet the insulation of the copper wires was good, and quite sufficient for conducting electricity through them. If that was a sample of what had taken place at such a depth, it was a proof that the iron covering did not give the support that was intended, and answered no good purpose beyond giving strength in the laying down of the cable.

Rear Admiral Sir EDWARD BELCHER, said, as it was impossible to arrive at a satisfactory conclusion from the discussion which had taken place, he would suggest that the Council of the Society be requested to appoint a committee for the purpose of prosecuting further inquiries into the subject.

Mr. OWEN ROWLAND said, he had been engaged by her Majesty's Government under the Board of Trade, in conducting very extensive experiments in the testing of cables for submarine purposes. They had all heard of those experiments, but they had no idea of the great extent of them, or of the time and labour that had been bestowed upon the testing of the best materials for submarine cables. Those experi-

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ments were in part published in the blue-book, but they were not all recorded there. It was deeply to be regretted that the Imperial Government had determined to ignore the recommendations contained in the report, in its first efforts to extend submarine telegraphy, since the publication thereof. He was glad this subject had been taken up by the Society of Arts, because he believed the discussion of it would tend to increased confidence in the practicability of submarine telegraphy; and if the Atlantic Telegraph Company acted upon the information and instruction given in the report of the Government Commissioners they might confidently look forward to the time when a permanent telegraphic communication with America would be an accomplished fact, to the mutual benefit of both countries.

The Chairman said it was now his duty to close the discussion for this evening. With regard to the proposition of Sir Edward Belcher, that a committee should be appointed by the Society to conduct inquiry into this very important subject, he might state that the Council had already appointed a committee to inquire into the destructibility of gutta-percha, and the best mode of its employment, but that committee had ceased its labours since the appointment of the Government commission. Whether the Council might think the present a good opportunity to appoint another committee to inquire not only into gutta-percha, but into submarine telegraphy generally, he could not say, but the recommendation of Sir Edward Belcher would be laid before the Council, and would have their best consideration. His present duty was to propose a vote of thanks to Mr. Webster, not only for his paper, but also for the kind manner in which he had stepped in to introduce the discussion this evening. He had had the good fortune to bring them to this point—that whereas, on the last occasion they mainly discussed the channel of communication, they had this evening discussed the mode of the communication. The question now arose as to what was the proper quantity of insulating material to use, and what was the best material for that purpose; and when they had settled that question they had to decide which was the cheapest and best mode of laying down the cable. These were difficulties which no one could doubt the energy and enterprise of this country would overcome, because, in the words of their late Royal President, if a body of Englishmen said they would succeed, their energy and indomitable courage never failed in accomplishing success. They might, therefore, hope in a short time to enjoy the great blessing of telegraphic communication with their trans-Atlantic brethren as quickly as they could now do with their friends all over England and on the continent of Europe.

The vote of thanks having been passed,

Mr. Webster said it gave him great pleasure if he had been of service in bringing before them an object of national importance, as he considered this to be. Having on a previous occasion taken upon himself to suggest the resumption of the subject, he would add one word with reference to the proposition of Sir Edward Belcher and the observations of the chairman upon it. It was clear that the matter of the Atlantic Telegraph was now reduced to comparatively narrow limits, consisting merely in matters of detail, and he could not conceive that this society could do itself greater credit than in giving the use of their rooms for the discussion of this subject.

The Secretary announced that on Wednesday the 18th February, a paper by Mr. A. Nesbitt Shaw, "On the best means for Promoting the Growth and Improving the Quality of Cotton in India," would be read.

The following communication has been received by the Secretary since the meeting:—

"Sir,—I was too sensible of the courtesy of the Council of the Society of Arts, in allowing me to be present and take a part in their discussion, to encroach upon their time by prolonging my observations last night; otherwise there were two topics upon which I should have wished to add only a few sentences. First, with regard to the route for an Atlantic cable, and, secondly, on the subject of the surveys already made of the bottom of that ocean.

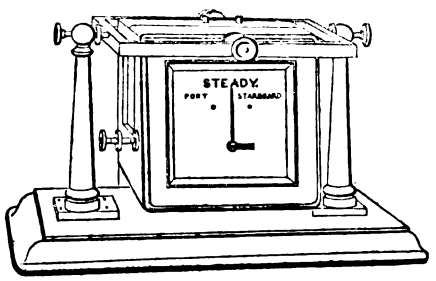
With respect to the first of these points, however, my object would not have been to depreciate the efforts of others in any direction, but to justify our company in their deliberate adhesion to their original line from Ireland to Newfoundland, from a conviction, founded on careful and wide inquiry, that it is the best if not the only certainly practicable line, as well as the one of which (subject to certain conditions on success, to which they have been justly subjected by the government for the protection of the public) they are in exclusive possession against all the world. Their line has been proved by experiment to be practicable, and we think it wise not to depart from this already trodden track, though modifications at the termini and landing-places may probably be admitted.

With respect to the surveys, it appears to have been forgotten or ignored, in former discussions, that two fresh and careful surveys were made, at my request, in the course of last summer, on each side of the Atlantic, by soundings at short intervals, for several hundred miles seaward from each coast, by officers and ships of her Majesty's navy, and with the happy results of proving that the descent into great depths, on the Irish side, is not by a "precipice," as some have conjectured, but by an easy and gradual incline; that the bottom is not rocky or infested by insects, but tranquil and undisturbed by currents, and consisting of "ooze" and soft and favourable material, calculated to protect rather than injure a cable lying upon or imbedded in it.

There may be points of rock undiscovered "no bigger than the President's chair," as suggested on one occasion, but the gravel bottom in the great depths has been ascertained to be, if not an absolute "plateau," as supposed by Maury, at least of a generally equable and plain surface. I am, &c. J. Stuart Wortley.

February 12, 1863.

SHIP-STEERING TELEGRAPH.



The above sketch represents Gilmore and Preece's ship-steering apparatus, the invention of Mr. Gilmore, who has practically used it in the Australian Colonies for five years on board the steamer *Wonga Wonga*. It is now fitted on board H.M.S. *Resistance*. The dial is suspended in front of the man at the wheel, and is actuated by an apparatus on the bridge, which is simply a counterpart of the wheel, only on a smaller scale. A positive current deflects the needle to "starboard," a negative current, to "port"—the normal position is at "steady." Every current sounds a gong so that attention is attracted by sound, while directions are given by sight. Every signal is acknowledged by another gong on the bridge.

Presuming the ship be steering a steady course and the officer in charge requires her "posted," he has simply to go to the wheel on the bridge, move it as though he were steering the ship himself, which deflects the index to the proper side, while it at the same time sounds the gong. The man at the wheel acknowledges this signal and alters his wheel accordingly. When the ship's course has been sufficiently altered, the index is brought up to "steady," and the gong again sounded.

This is a very simple and efficient telegraph for nautical purposes, and has been received with considerable favour by naval and mercantile authorities.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	... 2s. 0d.	per lb.
Second „	... 1s. 5d. to 1s. 9d.	„
Negro	... 1s. 1d. to 1s. 3d.	„
Java	... 1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine	... 2s. 6d.	per lb.
Genuine	... 1s. 8d. to 2s. 0d.	„
Reboiled good	... 1s. 5d. to 1s. 9d.	„
Ordinary Reboiled	... 1s. 0d.	„

February 25, 1863. Wm. Kirkmann,

4, *Howford Buildings, Fenchurch Street, E.C.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

HAWORTH'S SYSTEM OF TELEGRAPHING WITHOUT WIRES.

To the Editor of The Electrician.

Sir,—I make it a rule never to pay any attention to anonymous correspondents. As Mr. Haworth, however, has commented upon the re-

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marks I made a short time since at the Society of Arts, allow me to draw attention to the fact, that the discussion having been prolonged beyond the time allotted for that purpose, the detail of the experiments could not then be fully entered into.

Mr. Haworth paid me "one" visit a short time ago, when I asked him if he had any objection to his invention being tested by actual experiment; he said he had not, and pointed out to me how to arrange the various parts of the apparatus. I have preserved the pencil sketch made at the time, as indicated and approved by him. This was strictly followed in the experiments.

The apparatus used were constructed especially for this purpose. The primary coils were *thoroughly* insulated with gutta percha, the secondary coils by means of a resinous compound and india rubber. The plates of copper and zinc at each station were but an inch and a half from each other; they were each six inches square. The two stations were only eight yards apart.

The apparatus at each station consisted of a plate of copper and a plate of zinc, connected to a flat secondary coil containing nearly a mile of No. 35 copper wire. The secondary coil was placed immediately behind the plates, and behind this was placed a flat primary coil.

At the sending station the primary coil was connected with six cells of Groves' Battery, and contact intermitted. At the receiving station the primary coil was connected with one of Thomson's Reflecting Galvanometers, of small resistance, no more than that of an ordinary telegraph instrument.

With this disposition of apparatus *no current* could be obtained.

Crossing a river without wires is an old experiment. In March, 1847, I tried experiments in my own garden, and also across the Regent's Canal, with a single cell of Groves' Battery. Feeble but evident currents were sent across the canal 50 feet wide. The current received was but a minute fraction of that leaving the battery. In this case the distance across the canal was but one quarter of that separating the plates on each bank. When, however, these plates were brought near together, as in Haworth's specification, no visible signal could be obtained.

This experiment has been repeated by numbers in various parts of the world, and with the same well known results. When tried by me in 1847, I was unaware that the idea had occurred to Professor Morse, or anyone else.

To account for Mr. Haworth's assertions that he has worked from Ireland to London, and between other distant places, I can only suppose that he has mistaken some irregularity in the currents generated by his copper and zinc plates for signals.

If he *can* telegraph without wires, why does he not connect England with America, when he can earn £1000 per diem forthwith, and confer upon the world a great blessing?

Before speaking at the Society of Arts, I called at Mr. Haworth's house several times, and found him out on all occasions. I wrote him more than once, giving him the negative results of my experiments, &c. He, however, paid no attention to any of my communications. I enclose extracts from a letter to him detailing the way in which experiments were performed.

I have not been able to meet with a single individual who has seen a message transmitted by Mr. Haworth; and every one of those who are reported to have seen it, and with whom I have come in contact, positively deny it when questioned.

I have no hesitation in stating, 1st, that Mr. Haworth's specification is unintelligible; it is a jumble of induction plates, induction coils, and coils of wire connected together in a way that can have no meaning.

2ndly. That he cannot send electric signals without wires to any useful distance.

3rdly. From my acquaintance with the laws of electricity, I cannot believe it possible that he has ever communicated between distant stations as stated in his specification, No. 843, 1862.

4thly. Supposing for a moment that he could work, as stated, any person constructing a similar apparatus in the neighbourhood would be able to read the communications, and they no longer would be private.—Truly yours,

C. F. VARLEY.

Engineer's Office, Telegraph Street, London, E.C., Feb. 20, 1863.

EXTRACT FROM MY LETTER TO MR. HAWORTH.

"Last night I tried the experiment of working without wires, and, I am sorry to say, with entirely negative results. I followed your instructions to the letter. My secondary coils were 4 inches in diameter, 1½ inch thick, insulated by means of resin and india rubber, and containing each nearly a mile of No. 35 copper wire. My primary coils were 4½ inches in diameter, and 1½ inch thick, and contained about 150 yards of No. 18 copper wire, insulated by gutta percha.

"The zinc and copper plates were 6 inches square, and slightly curved, so as to form portions of a cylinder. These were buried in the ground, as shown in the accompanying sketch; the secondary coils being placed immediately behind the plates, the primary coil behind the secondary; distance between the two sets of plates 8 yards, the soil very damp, and I poured water around the plates to secure good contact with the earth. Battery power used, 6 cells of Groves' battery, equal to more than a dozen cells of Smee.

"The receiving instrument was a very delicate reflecting galvanometer, so extremely sensitive that when one of the secondary coils was attached to it, and twisted* only a quarter of an inch, so as to cut a few of the earth's magnetic rays, the needle moved 10 to 15 divisions.

"1st. Exp. At sending station the secondary was attached to the two plates, copper and zinc; primary attached to the battery. Receiving station, secondary attached to the two plates, primary attached to the galvanometer. On making and breaking contact with the battery at the sending station, not a ghost of current visible at receiving station.

"2nd. Exp. At the receiving station the primary was put in contact with the copper and zinc plates, the secondary in connection with the galvanometer. Sending station same as before; no result obtained.

"3rd. Exp. At sending station the primary was connected with the plates, and the secondary to the battery, yet no result whether the primary or the secondary were attached to the plates at the receiving station.

"4th. Exp. I connected the galvanometer at the receiving station direct to the copper and zinc plates, the current produced by the copper and zinc powerfully deflected the galvanometer on one side; magnets were then used to counteract this deflection, and at the sending station battery contact was made and broken with the primary, but no result. Primary was then attached to the plates, and battery contact with the secondary made and broken, still no result. The battery was then applied at the sending station, to the two plates in the earth, no coils in circuit, when a minute deflection was obtained; perhaps a 1,000,000th of the whole current entering the earth reached the galvanometer; but as the current from the zinc and copper plates at the sending station was so powerful, requiring powerful magnets to bring the needle into range, I could not estimate accurately its amount, but it was a mere ghost of a current received."

January 23, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—Will you be kind enough to forward to Mr. Owen Rowland a question which I wish to have answered, with regard to the very important subject of the Disintegration of Vegetable Fibre under Pressure.

He says, that the tarred hemp did not suffer from this cause. Will he be kind enough to inform us whether there existed *in the water* of the pressure tank, after the operation, any traces of tar, for if this were the case, then it is clear that the tar must only be regarded as a temporary protection to the hemp, and all idea of using hemp or other vegetable fibre to impart *strength* to submarine cables, must so far as the recovery from deep water is concerned, be entirely abandoned. It would be some progress to know what materials cannot be used in these cases; and I am afraid tar, whether in "compound" or as applied to hemp, comes under this category. In the one case it seems to succeed in spoiling the gutta-percha, in the other to fail in preserving the hemp, after a certain lapse of time.

In looking over last week's ELECTRICIAN, I observe a statement of Mr. Gisborne's, that he has seen gutta percha eaten "through and through" by marine animalcules

Now, it is no doubt interesting to the public to know, that Mr. Gisborne claims to have laid a subaqueous line (in 14 fathoms) in 1852, 12 miles in length, between Prince Edward's Island and New Brunswick; but, it is much more interesting and essential to that public to know all about the gutta percha.

Was it gutta percha covered wire "pure et simple," or like Mr. Siemen's celebrated specimen, was it originally hemp-covered; as this makes all the difference. The insects, in that case, in eating through the hemp slightly touched or cut (and then left) the gutta percha. A proof, and a good one, that that particular teredo, or whatever it may have been, did *not* enjoy gutta percha, though he had a partiality for hemp.

Will Mr. Gisborne be so kind as to give full particulars of the how, why,

* By this is meant that when the secondary coil was twisted about 8 degrees so as to cut a few of the earth's magnetic rays, a magneto-electric current was produced, capable of deflecting the galvanometer from 10 to 15 divisions.

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where and when? For although india rubber may thereby be exalted and gutta-percha abased, the public have a right to know which is destructible by such means, and what insulator, if any, may be trusted. I confess that if it were proved that gutta percha *had* been eaten through, as a matter of taste, I should reason that india rubber might be also a chosen pabulum for some of the many genera of teredo or mollusc; and, if so, we must seek for a silicated or other imperishable outer coating for cables. Glass bottles being one of the few things which are recovered unchanged from the sea after many year's immersion, always providing they were not subjected to much abrasion.

But I have a strong faith, that as gutta percha, and in a few instances india rubber, *have* resisted for years wherever they have been perfectly laid, Mr. Gisborne's friends were a very small coterie, if, indeed, they were not reduced to their last shifts, in consquence of some submarine famine.

J. H. SELWYN.

Chequers Court, Tring, February 22nd, 1863.

To the Editor of THE ELECTRICIAN.

SIR,— In making a condenser for an induction coil, it is necessary that the insulating sheets of paper should be well varnished.

I have heard somewhere that gutta percha, beeswax and resin, in equal parts, make a capital insulating varnish.

I accordingly made up this mixture, but found that the gutta percha would not combine with the other ingredients, and that the mixture was too thick and sticky to be laid on paper with a brush.

As I do not wish to waste this, I shall be glad if you or your correspondents will inform me how to dissolve the gutta percha, and cause it to mix.

Also how to make the varnish thinner, so that it will leave the brush. Should oil or spirits be mixed with it. I have tried wood naphtha, but to no effect.

Perhaps you can suggest a more suitable varnish. I do not like using thin gutta percha sheeting in the condenser, as it is full of minute pores, and liable to absorb moisture.—I am, Sir, yours respectfully

ARCHIMEDES.

CONDUCTIVITY AND RESISTANCE.

To the Editor of THE ELECTRICIAN.

SIR,—In order that "Relay Magnet" may not continue to mistake my meaning, as expressed in the memoir of Feb. 20, under the above heading, I find it necessary to inform him that the word *adequate* occurring in the phrase "an adequate source," might be struck out from the context without altering the sense in any particular. Your correspondent has invested a word, used in its ordinary popular signification, with an imaginary technical importance that has caused him to misstate my opinions, and, at the same time, complicate his own arguments. If he will erase the word he will then not be in danger of again misunderstanding it, and perhaps his objections in great measure may disappear with it; at all events, any that will remain may become more intelligible, and I will endeavour to satisfy him with respect to them, if he will make them known.

The gentleman who controls the vagaries of your compositors has allowed them in the first column on page 181, third line from the bottom, to make me give expression to a sentiment beautiful enough, no doubt, in its proper place, but hardly calculated to appear where it does. Instead of "truth speaks with so endearing a voice," I was quite content to be so *poetical* as to say the voice of truth is *enduring*.—Yours, &c.,

RICHARD LAMING.

To the Editor of THE ELECTRICIAN.

SIR,—Having sent a communication to the Editor of the *Engineer* on a theory of mine, which relates to the movements of the electric fluid along the wire of the needle telegraph and the wire of the galvanometer, he recommended me to propose the theory to you. So, with your permission, I will now do so. Now, you know that when a current of electricity is passing along the wire of the electric telegraph, or the wire of the galvanometer, if the needle of the galvanometer be brought immediately beneath the wire it will be deflected to one side; one side or end of the needle will be deflected on one side of the wire, and the other end will be deflected to the other side of the wire. Now, if the electricity is still passing in the same direction along the wire, and the needle be placed immediately *over* the wire, it will be deflected in the contrary direction; and when the needle is on a level with the wire, or in the same parallel plane, one end of it will dip and the other end will be elevated, but it will not be laterally deflected, both ends being the same distance from the wire. Now, if the needle be placed on the other side of the wire, that end of the needle which dips below the wire will now be elevated above it; now, if the needle be placed at right angles to the wire in the same parallel plane and one end almost touch the wire, when the current moves in one direction along the wire that end will dip, being depressed lower than the wire, but when the current moves in the opposite direction, the same end of the needle will be elevated. Now my theory is, that the electric fluid moves spirally along the wire, and not from end to end, as is generally supposed, direct along the wire. If it move direct from end to end, how should it deflect the needle to one side when under the wire, and to the other side when above the wire? how should the needle dip on one side of the wire, and the same end be elevated, when on the other side of the wire? how is it that when the needle is at right angles to the wire, that that end of the needle which is nearest the wire dips when the current moves in one direction, and is elevated when the current moves in the other direction? I likewise suppose that the electric fluid travels spirally around the magnet, and that two fluids are emitted from the ends of the magnet, one from one end, and the other from the other end; call them, for distinction, oxygenic and hydrogenic fluids, which together form the electric fluid. I likewise suppose that the currents which flow around the magnet or needle are influenced by the current of the wire, and that they have an influence over the two fluids which are emitted from the ends of the needle; and that when the electric current of the wire temporarily affects the currents flowing along the surface of the magnet or needle, it likewise affects the fluids coming from the ends, perhaps diminishing its force on one side, this remaining the same on the other side, or, in some casesbeing increased, according to the position the needle takes in regard to the current. Now, when I say one side of the needle, I do not want it to be understood that I mean one end; I mean the sides of the needle of the galvanometer, the upper side and lower side. I think that, by means of the above theory, I can explain all the movements of the magnetized needle when influenced by electric currents. I also think that the theory of electricity moving spirally along conducting wires will easily explain the movements of electro-chemical cylinders, moveable and fixed, their attractions and repulsions. Not possessing proper means of testing the above theory to the extent that I could wish, I humbly submit it, through the medium of your valuable paper, to those who do possess them, when their experiments will set the matter at rest.—I am, yours, respectfully, B. R. MILLS.

Ashton-under-Lyne, 20th Feb., 1863.

Telegraphic News.

LONDON DISTRICT TELEGRAPH.

THE half-yearly meeting of this Company was held on Thursday, at the offices, Cannon Street, Mr. R. Taylor in the chair.

The report, which has appeared in THE ELECTRICIAN, was taken as read.

The CHAIRMAN, in moving the adoption of the report, said that one reason for the Company not succeeding better than it had was the general depression of trade during the past year. By a Parliamentary return which had been issued the shareholders would find that the Company had progressed more than any telegraph company in existence. There was only one item in the accounts which required explanation, and that was a sum of £2,394 for sundry creditors, and to meet this there was a sum of £1,704 from sundry debtors and £947 cash at the bankers, making about £9,651 to meet £2,394. The amount from debtors was for rents due, and since the report was issued the greater part of this sum had come in. The amount paid for the rent of the Company's offices in Cannon Street had been reduced last half-year by £200, and further reductions would be made under this head.

Mr. EAMES, in seconding the motion, said he believed everything had been done, and would be done, by the Board and manager to promote the prosperity of the Company; but still he must express his regret at the unsatisfactory result of the half-year's working, and he thought that, as the Company was worked at a loss, it had now arrived at a crisis, and it was therefore a question for the directors to consider what should be done.

After some discussion, the CHAIRMAN, in answer to questions, said that while the loss on the previous year's working amounted to £1,900, it was only £894 for the past year. He had but little doubt that if it had not been for the general depression of trade, and the war in America, the revenue of the Company would have shown a more favourable result. With respect to the complaints which had been made against the Company for delay in messages, &c., out of 20,000 messages, the average for four weeks, they did not have six complaints. With respect to the agreement made with the Magnetic Company, the Board were now in communication with that company with a view of still further carrying out that agreement.

The report was then adopted.

Mr. Austin and Sir C. Bright were re-elected directors.

Sir C. BRIGHT said he had every confidence in the undertaking, as a slight increase upon the present revenue would enable the directors to pay a good dividend.

A vote of thanks was passed to the chairman, and the meeting separated.

AMERICAN SUBMARINE CABLE.

THE House of Representatives has passed a bill, providing for the establishment of a submarine telegraph cable from Fortress Monroe to Galveston, communicating with intermediate points on the coast.

A DEPUTATION from Bonelli's Electric Telegraph Company, consisting of Mr. Peter Rylands, of Warrington, deputy chairman; Messrs. Cook, Robinson, and Pilkington, directors; Mr Elliot, solicitor; and Mr. Gwinner secretary, introduced by Mr. Hibbert, M.P., had an interview on the 19th inst., with the Right Hon. T. Milner Gibson, M.P., at the office of the Board of Trade, on the subject of the New Telegraph Bill.

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The Electrician.

Vol. III. No. 70.—March 6, 1863.

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MR. LAMING'S THEORY OF CONDUCTION.

With all due respect for Mr. Laming's acquirements and general ability for argument, we must observe that he totally misapprehends his position in the discussion which has arisen relative to his theory of voltaic conduction. He has forced us to take in its literal signification the astounding statement contained in his article inserted in our 67th Number, and prefixed to his communication in the following issue, without appearing to think it necessary to give the slightest experimental evidence in support of an assertion in contradiction to all experience. Without perceiving, as it would appear, that the onus of disproving a multitude of facts involved in the fundamental formula of Ohm, and of establishing a statement based upon his own theoretical views, is necessarily incurred by himself; Mr. Laming states this week that "it is clear we can at present have no proof" that resistances once found to be equal (with a low battery power), remain so when their equality is tested under different conditions (with higher battery power). Has Mr. Laming any proof that the fact is different from what is implied in Ohm's formula? In the contrary case, is not our contributor guilty of an unjustifiable degree of temerity in questioning a result which is established by every experiment which has been tried in the laboratory, and confirmed by all practical experience in testing the resistance of conductors? The proof required of us is clearly superfluous, and the assertion that we are unable to supply it is excusable only on the ground that Mr. Laming is quite unaware of the extended verification that the accepted theory has received, and of the multitudinous facts by which his own hypothesis is negatived. In addition to the *experimentum crucis* we have suggested, and which should have been sufficient to convince our opponent that his views relative to voltaic conduction are wholly untenable, we can only recommend Mr. Laming to test three "equal resistances,"—of thick wire, fine wire, and of both combined in any manner he may please, with a battery of one cell in the first instance, and subsequently with a battery of one hundred or more cells. He will find that the quantity of electricity conducted by any one of the three wires will be precisely the same as that which will traverse the others with the same battery. If it can be of any satisfaction to our contributor, we may state that we have ourselves repeatedly performed the experiment, with this result.

"While," as we observed in a past Number, "we admit that the formulæ of Ohm are in exact accordance with our general experience of voltaic action, we may safely allow that they may, to some extent, be based upon a purely artificial foundation." It is legitimate, therefore, that we should give our attention to any explanation of voltaic phenomena, equally in accordance with observed facts, which may be founded upon a different and perhaps a more extended basis. So long as this may be found in harmony with the known results of experiment, it is entitled *ab initio*, to careful and unprejudiced examination. Mr. Laming, however, is at variance with the law of Ohm, and with ourselves, upon a question of fact. We assert that the formula of Ohm, expressing the conditions upon which is dependent the quantity of electricity traversing a voltaic circuit, is in complete accordance with, and necessarily indicates, certain experimental results to which a statement of Mr. Laming, derived solely from his own theoretical data, is in evident opposition. It is clearly incumbent upon this gentleman, therefore, either to negative our "experimental results," and thus at the same time to impugn the accuracy of the data given by Ohm, or at least to signify that his own theory does not necessarily imply a contradiction to both. Then, and then only, can we receive with pleasure or profit any further elucidation of the views, upon this particular subject, of our talented contributor. Most assuredly, it can answer no useful purpose to neglect the unmistakeable import of facts while we endeavour to obtain a clearer insight into an hypothesis already found to be at variance with them.

Mr. Laming obviously does not apprehend the full meaning of the formula $I = \frac{E}{R+r}$. He remarks that "so far as it relates so facts which suggested it, and with which it actually corretponds, *it remains unquestioned.* It does not strike our contributor that this is equivalent to stating that his own assertions, past and present, so far as they relate to the theory of the voltaic circuit, are already disproved to his own satisfaction. The expression is of itself susceptible of the "extension" that Mr. Laming proposes to give to it. It implies that if the sum of $R + r$, in several circuits respectively, be the same, the value of I will be simply proportionate to E, in each case; and that I will increase in the same ratio if in these circuits, severally, E be increased to n E or R be diminished to $\frac{R}{5}$.

Unfortunately for his hypothesis, Mr. Laming attacks the most unassailable portion of Ohm's theory. We are aware that M. Du Moncel has recently drawn attention to the fact that, in the general expression of Ohm, the variation of E, when $R + r$ is increased or diminished, is not taken into account,*—a circumstance which he considers as bringing into question the accuracy of the formula. Mr. Laming, however, does not touch upon this point, the facts relative to which have been very clearly explained in the Appendix by Mr. Latimer Clark to the Government Report of 1861, without, as we consider, detracting from the value of Ohm's formula.

It will be seen that our present remarks apply in great measure to the statements and conclusions put forward by Mr. Laming in this Number. It is quite unnecessary that these should be more fully commented upon. We are ready to admit that in some points they are not only plausible upon abstract grounds, but might possibly admit of such modification as would bring them into accordance with known results. Thus the hydraulic analogy, which has been shown by a correspondent to be erroneously applied, might perhaps, if carefully followed out, give a correct physical interpretation of the observed phenomena of conduction in the external portion of the circuit. Without entering too far into the value of this analogy, we may observe that, if Mr. Laming has ever followed the tide of Thame or Isis in a small skiff, he may doubtless have noticed an unusual velocity of transit when passing between the piers of bridges, or wherever any similar obstruction was opposed to the stream; and, again, that there was no perceptible difference of level in the water on either side of the obstruction. Let him take these familiar illustrations in conjunction with the fact, expressed in the words of Professor Daniell, that, in the voltaic circuit, "chemical affinity *waits upon* the collecting and conducting power;" and he may then probably render his "laws of electricity in motion" as perfect, and as completely in accordance with known results, as are his own admirable researches, in another branch of the science, contained in some of our earlier Numbers. His present theory, which,—*si non é vero, é ben trovato*, might thus, hand in hand with experiment, and guided in her footsteps, lead to valuable theoretical conclusions within the province of voltaic electricity.

* "Mémoire sur les variations des constantes des piles voltaiques." Par M. Th. Du Moncel. Comptes Rendus LII. p. 450.

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ON THE LAWS OF ELECTRICITY IN MOTION.

BY RICHARD LAMING. M.R.C.S.

Before entering upon this subject, I must say a word with reference, to what appeared in the last number of this periodical. The Editor, to sustain the assertion made at the foot of page 192, would have to prove that what he is relying upon as *facts* are not untrue generalizations that I could trace to his mistaking *observed acts* of conduction for *unobservable powers* of conduction. It is clear that he can have at present no such proof. Conductivity, which is the power to conduct, is not *always* measured by conduction, which is conductivity in exercise. The power often exists without the act, but the school of Ohm, not that of Nature, identifies one of these things with the other, and hence cannot avoid erring in some of its conclusions.

It has so happened that the Editor, who is entering upon the defence of Ohm's theory, has just awakened sympathy in his cause by pourtraying the late Professor's personal struggles against a tide of opposition setting in in early life against him. We may commiserate the individual, but we ought in his case, as in every other in which the interests of truth are to be secured, to be able to dismiss from our minds all considerations of private import when we address ourselves to the work which the man has bequeathed to his fellow men either for good or for evil. However great may have been the mathematical genius of Ohm, and the good therefrom derived, I cannot regard him as a benefactor to the *physics* of electricity; nor will I hesitate to acknowledge that it has caused me no surprise that his work met with so little acceptance from his early contemporaries; for, masterly as his system may be as a mathematical production, it must have appeared to *savans wishing to progress in the knowledge of physical cause and effect*, as drawing too largely on their credulity, and as violating too palpably the common principles of mechanical philosophy. The lasting mischief done to physical electricity in the early days of its development by the mathematical theory of another celebrated calculator, and now again by Ohm, is, in my estimation as a physicist, too unquestionable to admit of my believing that electrical science, as understood in their times, afforded, as a starting point for demonstration, a solid foundation of facts illumined by the true principles of nature; and therefore I rejoice, rather than regret, that the "mathematical theory of the voltaic circuit," by Ohm, has not been followed by the "series including all the branches of electrical science," contemplated by the Professor. It is well that the *lions* of our science should not be caught in meshes; for, when once entangled, it is very hard work for its little *mice* to set them free again.

If electricians, generally, may be supposed capable of appreciating "the sacrifice" to which Ohm so feelingly alluded, I may with some reason claim to be no exception. I say this in order that my dissent from his doctrine, as an exposition of physical cause and effect, may have fuller force. My electrical career, however much less aspiring, has had all along some features in common with that of Ohm, enough to have made me susceptible of sorrow at the recollection of his private sufferings; and, at length, my earnest inquiry into doctrinal electricity, commencing with the winter of 1812-13, and never since suspended, has brought me also to the promulgation of a theory which I have submitted for public adoption. I cannot say it is opposed, nor that it is admitted; it appears to me, so far as the eminent in electrical physics are concerned, to be winning its way amid a silence it has created for itself, none venturing to be publicly distinguished for either embracing or rejecting it. I know, as a fact, that for years it has been the subject of private thought, so that it is fair to assume that deficiences would, ere this, have been openly pointed to had it not been seen to abound with internal evidences of truth and sufficiency that render it proof against attack. My acquaintance with it has been too long growing, and my application of it too extensively made, to leave in my mind any doubt of the place it is destined to occupy; and, if at times I have felt somewhat weary of the "hope deferred," I have soon been able to console myself again by some wholesome reflection. The real devotee to science, for its own sake, cannot discover too soon that he should look within himself for his only sure reward—one that, even at the outset, could not be denied to the truth-seeking, truth-loving Ohm. Due honour to his memory!

This has been a digression, but, under the circumstances, I hope it will not be deemed an inexcusable one. I will now turn to the definitions I promised in my last communication, as those furnished by the equivalent theory of electricity, and I submit them as capable of throwing all necessary physical light upon the most intricate problems in electro-telegraphy; the object being to bring them into comparison with such as may be advanced as flowing from the theory of Ohm.

1. Electricity and its Normal Relation to Matter.—The equivalent theory regards electricity as a ponderable fluid, attracted around the smallest parts of all common matter in definite quantities that are represented by their respective weights, and as being probably the sole cause of those weights.

The matter of electricity is supposed to consist of particles that tend to gravitate together into a mass, which—1stly, they are prevented from doing, in the normal condition of things, by the attraction they exercise for the common matter to which they respectively belong; and which, 2ndly, they immediately do when they are disconnected, and sufficiently removed, from their equivalents of matter.

All the ultimate particles of matter being assumed to be spherical atoms, particles of electricity are conceived to surround each common particle in the form of successive concentric shells, the last or outer shell being occasionally perfect, but more generally imperfect to a greater or lesser extent; and the degree of completeness of the external spherical shell of electrical particles is regarded as varying also with temperature, by reason of a transfer of individual particles from one shell to another, when those shells either contract or expand.

Whenever two imperfect external shells intersect each other, the intersection places part of the electrical equivalent belonging to each of the centres of common matter nearer to the other centre than is a corresponding part of its own electrical equivalent; whereby particles of electricity in the two imperfect external shells become *in part* attracted by two centres, thus establishing the bond of union which is called cohesion when the centres have the same nature, and chemical affinity when their natures differ.

2. Induction.—Whenever two unlike centres of common matter, which have been adhering together by the electrical bond of union, are separated by mechanical force, one of them may become plus, and the other minus; for each of the particles of electricity that constituted the bond is indivisible, and may have been attracted unequally by the opposite centres. *Induction* is the projection of electrical attraction—not from one to the other, across the increased distance, for that would be still normal electrical attraction, but between the plus electricity of one of the two centres and some foreign common matter at a lesser distance than its former associate; and also between the minus matter of the other centre and foreign electricity less far distant from it than the removed portion of its own. By this induction common matter and electricity still attract each other in equivalent proportions at the smallest possible distance. The term is applied to all similar action of bodies electrically plus or minus, however they may have acquired their respective electrical conditions.

3. Charge.—A centre of common matter whose series of shells of electrical particles terminate externally with a shell that is imperfect may attach around it, *within its imperfect shell*, other foreign particles of electricity, without attracting in the whole more electricity than its natural equivalent. For as many electrical particles as find places vacant in the imperfect shell will each have part of itself nearer to the centre of force than the whole of any one particle of electricity previously existing there, that part—and that part only—being attracted by the centre. A centre thus attaching around itself additional particles of electricity beyond its normal number, and no one of which in its outer shell it wholly attracts, is regarded as having a *charge*. And the same term is used in the negative sense to denote the electrical condition of a centre of common matter with an

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external imperfect shell from which some of the electrical particles normally belonging to it have been removed.

Charge thus collected, whether plus or minus, acts by induction; and the extent of induction afforded determines the amount of charge that may be collected, or the charging capacity, up to the limit of the number of vacant places in the imperfect shells.

4. Intensity is the force of the attraction exercised, for the time being, between any particles of electricity and the common matter by which they are held, or towards which they tend to move. The equivalent theory regards *intensity* as increasing as the squares of the numbers of electrical particles acting on the same portion of common matter. Thus, under any given extent of induction afforded, a double number of particles, plus or minus, act with a quadrupled force, and so on for all other numbers.

5. Quantity.—This term, when applied to electrical charge, is expressive of the number of particles of electricity that are plus or minus, irrespective of the intensity with which the charge is acting.

6. Conduction.—When electricity passes from some position to another in which it need exert a less exalted intensity, or none at all, it is sometimes *conducted*. For this to happen there must exist between the plus and minus charges, connecting them together, an uninterrupted line of centres of common matter, each centre having its external shell of electrical particles more or less imperfect. And *conduction* consists in the gliding of the accumulated electricity from each imperfect shell to the contiguous one in the direction of the minus charge, under the force of induction and acting along the line, always at a uniform distance.

7. Insulation.—Electrical charge is *insulated* when it is surrounded by centres of common matter which either have no imperfect external shells of electrical particles, or, being in possession of them, have them placed by the gaseous condition so far apart as not to intersect one another.

8. Conductivity means the capacity to conduct electricity, which varies as the square root of the intensity of induction, and as the number of the lines of conduction: and also with the imperfection of the external spherical shells of the particles of the conductor, variation in the latter respect conferring upon each particle its own specific conductivity, and which will not be uniform for all temperatures.

9. Discharge.—Electricity may pass from one place to another, where it will either exert a lower intensity of induction, or else cease to be a charge, without the intervention of a conducting line between the plus and minus charges, by overleaping the distance between them. This is *discharge*, and, theoretically brought about, whenever, in the absence of conduction, the intensity of induction is made to exceed that of the attraction by which the charge is retained on the imperfect external shells of the common centres.

10. Motive Tension means the force with which charge is passed either to a lower intensity of induction, or to the normal condition of equilibrium, on an opportunity for one or the other occurring. When the movement of electricity is between centres all charged plus or minus, the *motive tension* is equal to the difference between the existing and the resulting intensities; when the movement terminates in the normal state of equilibrium the motive tension is simply equal to the intensity of charge; and when plus electricity moves into minus matter the two charges need to be separately calculated as though they resulted in the normal equilibrium, the two results added together, and the total taken as the *motive tension*, putting out of consideration any unbalanced charge, plus or minus, that may remain.

11. Resistance.—Electricity being ponderable matter, is subject to inertia, and cannot be put into motion without an application of force, which force it may be said to *resist*. The *resistances* of all the particles of electricity are equal, and repeated each time they are forced into motion. The *resistance* in a conductor for each particle of electricity forced through it, is simply as the length, because its stopping places are in number proportionate to the length; and for larger quantities of electricity the *resistances* are as the length of the conductor multiplied by the number of electrical particles passing through it.

12. Velocity is the speed with which electricity moves, under the impulse of motive tension, either when discharged or conducted. In the former case, when once in motion, the *velocity* of electricity is diminished only by mechanical impediments to its passage; and in the case of conduction the *velocity* is the joint product of motive tension, and the resistance of inertia.

13. Signalling Power.—This is measured by the quantity of electricity arriving at the end of a conductor in a given time. It varies directly: 1st, as the motive tension; 2ndly, as the sectional area of the conductor; 3rdly, as its specific conductivity; and 4thly, as the square root of the intensity of induction; and inversely, 1st, as the quantity of electricity detained upon it as a charge, and 2ndly, as the resistance opposed to the motion of the electricity.

14. Voltaic Apparatus.—The theory does not exempt this apparatus in any particular from submission to the ordinary electrical principles above defined, nor invest it with any special influence on the telegraph conductor that would not be exercised in some measure by every other source of electricity. It is generally employed because it is the best means at our command for supplying in the form of charge, and with sufficient intensity, the abundant quantity of electricity always demanded in a mere instant of time for telegraph service—submarine in particular. For this discussion (which does not embrace the physical causes of electro-motion) it will suffice to regard the poles of a voltaic apparatus, whether it be composed of a single set of elements or a greater number, as conductors inexhaustibly charged, one by the other, plus and minus respectively, to a degree of intensity that may be reduced by a rapid abstraction of charge, but never, under any circumstances, increased.

With respect to a single set of voltaic elements, we must view it—1st (in conformity to universal mechanical principles), as producing an effect varying with its own dimensions operating as a cause; 2ndly (which is dictated by observation), as varying in effect with the nature of the elements of which it is constructed. When more than a single set are joined together in series, another consideration has to be added: forasmuch as one set of voltaic elements can accumulate at its plus and minus poles a given quantity of charge, so it is conceived that any other number of sets arranged in series can accumulate at its extremities corresponding numbers of equal quantities of charge, making a sum total represented by the size of the elements, multiplied by the number of sets.

Conclusion.—Thus ends the series of definitions I have to submit, and what I propose is, that the Editor point out wherein he may conceive they do violence to fair inductive reasoning, founded upon the common observation of facts, and those metaphysical considerations of time, space, number, measure, cause and effect, by which the minds of philosophers universally are governed. At the same time, he can set forth his definitions of things embodied, actually or virtually, in the theory of Ohm, that they may be submitted to a similar ordeal. The discussion will then, at its commencement, benefit all who enter into it; and, what is of paramount importance, enable ourselves as disputants, when we come to appeal to an "experimentum crucis," to distinguish better between fact under observation and our inferences from it, which now we might be apt to consider as parts of its narrative, and thus be betrayed into false conclusions.

REMARKS ON A PAPER BY M. J. H. BLERZY, "ON THE MECHANICAL THEORY OF LAYING SUBMARINE CABLES."

BY CAPTAIN SELWYN, R.N.

In the *Annales Télégraphiques*, for November-December, 1862, I find a paper by M. Blerzy, "On the Mechanical Theory of Laying Submarine Cables." I hope our telegraphic allies in general, and M. Blerzy in particular, will permit me to point out some errors into which he appears to have fallen. First of all, it has been fully demonstrated by

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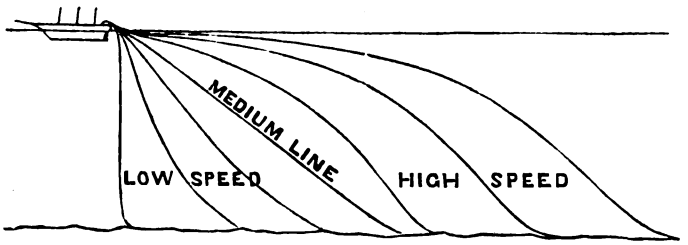
Mr. Gravatt, F.R.S., and allowed by Professor Airy, that there was a great mistake in considering the curve of a deep-sea cable as a catenary curve, and that such a curve is only obtained when the time occupied in reaching the bottom, by a given cable in a given number of fathoms, is less than the time in which the ship has gone over the same distance on the surface:—

Given depth of water, 33 fathoms
Rate of sinking of cable, 2 miles per hour ... } nautic mile
Rate of ship, 2 miles per hour... ... ... } =6,080 feet.

Here the cable will sink through 33.1 fathoms in one minute, and the ship will have gone over the same distance on the surface. Therefore the *curve* (?) will be nearly a straight line, or it will be the nearest approach to a medium between two extreme cases. One of these is the case in which the ship being stationary, the curve approaches to a vertical; the other, that in which the cable being so light as nearly to float, it approaches to a horizontal line. When the speed of ship is greater than the rate of sinking of cable, the curves are all upwards, or convex, to the surface of the water. When the rate of sinking is in excess of the speed, the curves are all catenary. Owing to the necessary comparative lightness of long or deep-sea cables, they must all come under the former category. Most shore-ends, or shoal-water cables, will come under the latter.

These curves may be thus represented:—



Now, 2 miles per hour (the rate of descent of a sounding lead drawing down a fine line) is probably much in excess of what we ought to allow as the rate of descent of a cable, and 2 knots, as speed of ship, far too little, therefore the curve becomes a very long one, and all the cable which cannot sink in the time must float, or be laid along the surface, *i. e.*, if the ship goes 5 knots per hour, and the cable in the same time sinks 2 miles (nautic), then 3 miles will be laid along the surface at any given moment. This is all exposed to the most superficial current, and constitutes the great danger of over-light cables. On reaching or nearing the bottom, all the curves become catenary, and in the high-speed curves this will be a curve of contrary flexure. The most important action of this curve is, that of ensuring the exact following of all irregularities, as valleys, &c., on the sea bottom.

It cannot be too much urged that the rate of sinking does not, and cannot, increase as the rate of paying out is increased, and in the case of pitching this fact has an important bearing as causing, or tending to cause, "kinks."

The cause of the upward curve has been ably shown by Mr. Gravatt, F.R.S., to be the resistance to cutting descent of the cable, by the water, and is similar to that which would be felt in the case of the progression of a similar cylinder, say §-inch diameter, and some miles long, through water, or it is the same as a current of a given velocity would exert on any given cable laid across it. At 2 knots I have calculated the resistance per mile, or the force exerted by a current of that velocity on a §-inch cable, at 1 ton 12 cwt. per mile.* Now, taking the case of the ship going 5 miles per hour, and the cable sinking 2 miles in the same time, as above, we have no less than 4 tons 16 cwt. tending to break the cable, or drag it out of the ship. And if we yield to this strain, as we must do, the cable can sink no faster than it did before, so that the only effect is to increase the quantity exposed to the current, the cable then taking the horizontal curve due to the composition of forces. True it is, that the cable will sink in the real path of the vessel; but there will be such apparent loss, that most men would think it necessary either to reduce the speed of the vessel, or to cut the cable. I do not, however, recommend either of these courses; but, on the contrary, an increased velocity of ship. It would be needless to follow M. Blerzy through all the errors which are the necessary consequence of a mistake in the basis on which he founds his argument. It may suffice to examine the conclusions which he draws, and which he sets forth as fundamental principles. These are three, see page 531.

1. That the speed of ship and tension of cable vary simultaneously.
2. That the resistance of the break, and the weight of cable in water suspended vertically, ought to differ as little as possible.
3. The limit of accessible depths is that of the *vertical soundings*.*

Now, as to the first proposition.

Supposing a cable weighs 1 ton per mile, and the ship passes from 1 mile depth into 2 miles, what has the speed of the ship to do with the increased tension, which is always as the depth, not as the length of the curve, as Mr. Blerzy, in another place, mistakenly assumes. If there were 20 miles of cable out astern of a ship the weight would be, if in two miles' depth of water, no more than 2 miles weight.

2nd. According to this, there ought to be always a resistance or brake power applied equal to the weight in that particular depth of the cable in water. What becomes of the upward pitch of the vessel and its effects? What of the previously described effects of current? Such a proposition is not tenable for a moment.

3rd. The limit of accessible depths, or, to put it in English, the depth of the route chosen, is the measure of the tensile strength required of the cable. Not so, for the engineering law is that no more than one-fourth of the breaking strain should ever be put as a constant load on any structure. We cannot, indeed, from the necessities of the case, get such an Utopian strength in this instance of cables, but we must approach as nearly to it as we can. Therefore it would be absurd to say that a cable whose tensile strength was equal to two miles of itself in water, would be a good cable to lay in two miles depth. In England we try to get, for such a depth, one which will support six miles, or, at least, four, not because we should not like the higher tensile strength, but because here we find ourselves on the horns of a dilemma, and are obliged *ex necessitate* to resort to a compromise. If the cable is of high specific gravity, *quoad* water, and will sink fast, it cannot have a high modulus of elasticity; if it be light, and therefore has great advantages as to tensile strength, then it will sink slowly and will incur the dangers I have shown to be incidental to such cables.

M. Blerzy says, p. 533, that if there is much slack lost it would be unwise to accelerate the speed of ship. I totally disagree with him for the reasons before stated. If, on entering and observing loss of cable from the effects of a current, I were to slacken my speed, I should certainly lose less cable per cent. per hour, *but* I should remain longer in that current, and increase my chances of meeting another. That alone will be a perfect break which never requires an engineer to look after it, and will accommodate its tension to the weight hanging on it, by the action of that weight never opposing an absolute resistance, as machinery, however cunningly devised, will always do on board a ship in a gale of wind, and never requiring the engineer to look at a chart where the soundings may, or, more probably, may *not* be laid down for the particular spot (or within 10 miles of it) where he at that moment finds himself (or, more correctly) supposes himself to be. Such a machine I have devised, and I speak the more confidently since it has received the open support of my own profession, and the approbation of not a few engineers; and, if M. Blerzy should wish it, I shall be happy to send him detailed explanations on the subject, as well as the mathematical exposition of Mr. Gravatt's views, which I have so freely quoted.

As regards the recovery of cables, to which M. Blerzy also refers, I believe great modifications will have to be introduced. I cannot con-

* Resistance of a cylinder in water, taken from Col. Beaufoy's experiments, 11·8 lbs. at knots.

* He means, evidently, is the measure of tensile strength required.

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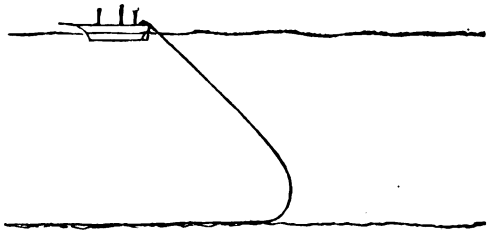
ceive a more lubberly plan than that of hauling the vessel astern by the cable. The right way to lift a cable, is to run over it as shown under, but to do this successfully requires also peculiar apparatus, in case of catching a rock or other obstacle on the bottom.



ELECTROMOTIVE FORCE AND RESISTANCE.

(From Daniell's "Introduction to Chemical Philosophy.")

NEXT in simplicity to the arrangement of the concentric spheres of generating and conducting metals, is that of a rod of zinc within a cylinder of copper. When the latter is six inches in height, and eleven inches in circumference, and the rod of the former, of the same height and half an inch in diameter, is placed in a membranous cell in its interior, the whole being charged with acid and solution of copper as before, the amount of circulating force is nearly the same as in the sphere before described. This arrangement is of course much more convenient for the purposes of experiment than the former: and its known geometrical relations adapt themselves readily to mathematical calculations.

We will now proceed to show how these may be applied in a perfectly elementary manner, and what beautiful simplicity and precision our subject assumes when we are able to submit its results to the correction of strict mathematical demonstration. We are indebted to Professor Ohm, of Nuremberg, for the simple formula which will be our guide in pursuing the remainder of this investigation.

It is obvious that in studying the phenomena of current affinity we have to do with an active force and with certain resistances to that force, as has been already pointed out. It is equally clear that the effect produced, or the amount of work performed, by such a combination, as indeed by all other natural forces, must be directly proportioned to the force and inversely to the resistances; and such proportions may be represented in a very usual way by a fraction, the value of which varies directly as the numerator and inversely as the denominator; as

$$\frac{E}{R + r} = A$$

In which equation E represents the *electromotive force*, as it has been termed, or, approximatively, the force of affinity between the active metal and one of the ingredients of the liquid compound upon which it acts; R the resistances in the cell (consisting principally of the affinity of the ingredients of the liquid compound for each other, to be overcome): r the amount of exterior resistances (such as that of the wire by which the connection between the generating and conducting plates is made); and A the effective force, measured by the effect produced or work performed. The distinction of the resistances into two kinds, interior and exterior, R and r, is of great importance, inasmuch as they are not influenced by the same circumstances, and we are thus enabled to deal with them as independent quantities.

But it is desirable to carry this analysis a little further, and to consider that E does not strictly represent the force of affinity between the active metal and one of the component parts of the liquid, but the balance of several active forces in the cell:

1st. The superior affinity of the generating plate for one of the ingredients, which we may designate as B.

2ndly. As the conducting plate itself can rarely, if ever, be considered as indifferent to the same ingredient, this inferior affinity must be taken into account, and represented by b.

3rdly. The affinity of the constituent of the liquid evolved upon the conducting plate for the other constituent which combines with the generating plate, must also be estimated, and called e'. The two last tend to produce a current in the opposite direction to B;

$$\text{therefore } E = B - (b + e') \text{ or, } B - b - e'$$

Again: R, or the resistance in the cell, varies directly as the depth of the liquid (or the distance between the generating and conducting plates), which we will call D, and inversely as the area of the section of the liquid, which may be represented by S, and these ratios may then be represented as before by a fraction; as

$$R = \frac{D}{S} *$$

r represents all the exterior resistances; and in our present investigations is confined to that of the wire of communication between the generating and conducting plates. It also varies inversely as the area of the section (*i.e.* the square of the diameter), which may be designated by s, and directly as the length l, or distance through which the current passes out of the cell;

$$\text{therefore } r = \frac{l}{s}$$

Let us now inquire particularly what it is we mean by the section of the liquid conductor. The limits of the section of the metallic conductor are strict and easily determined; but taken into consideration the diffusive nature of the force which we have just illustrated, and which we have even traced to the back surface of a conducting plate opposed to a mere point of generating metal, it is not at once apparent how the limits of the action are to be defined.

In a cell composed of a generating metal, with a conducting plate of equal dimensions, the interposed liquid only wetting the opposite faces of the two metals, the area of the section of the liquid will clearly be equal to the area of the acting surface of the conducting plate. In case the two metals should be immersed in a trough in such a manner as to allow of the liquid being in contact with both sides of the plates, it is also probable that the action of the back surfaces might be disregarded without danger of material error in our calculations; although we know, in fact, that they would not be wholly passive: up to this point, therefore, there is no difficulty in the application of the formula; for by doubling the size of the plates we double the area of the section and halve the internal resistance, and

$$\frac{E}{R + r} \text{ becomes } \frac{E}{\frac{R + r}{2}}$$

But how are we to determine the area of the section of the liquid part of the circuit when the surfaces of the generating and conducting plates are not equal? as for instance, in the case of a rod of zinc placed within a cylinder of copper? Is it referrible solely to the surface of the conducting plate? or is it limited by the mean of the surfaces of the two plates? If the latter, it is clear that the result would be the same whether the generating or conducting plate were the larger of the two. A rod of platinum placed within a cylinder of zinc ought to circulate the same amount of force as a rod of zinc placed within a cylinder of copper; the dimensions in both cases being respectively the same. An appeal here lies to experiment, which accordingly has been made in the following way: Hollow cylinders of amalgamated zinc with platinum wire, and wires of amalgamated zinc with platinum cylinders, were constructed, all of equal heights; the liquid in contact with the zinc consisted of dilute sulphuric acid (8 water 1 acid) separated by a porous tube from strong nitric acid in contact with the platinum. The contact between the metals was made by a Breguet's thermometer, adapted to the purpose of showing the amount of circulating force, or A of the formula, by the difference of temperature between the two metals of which it was composed. The results are shown in the following table:—

TABLE XLII.

Diameter of Zinc.	Diameter of Platinum.	Degrees of Thermometer.
inches.		
$2\frac{3}{4}$	wire	274° Mean of three observations.
wire	$2\frac{3}{4}$	255 Mean of three observations.
wire	$1\frac{3}{8}$	279
$1\frac{3}{8}$	wire	273
		270 Mean.

The needle always returned after each experiment to the degree from which it started. There can be no difficulty in taking these

* The resistance of the liquid is here assumed to be constant; but in reality it is specific for different liquids, and depends upon the nature of the liquid, the degree of saturation (if a solution), and the temperature.

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results as sensibly equal; and it is therefore evident that a wire of platinum placed within a cylinder of zinc, established a current of exactly the same force as a wire of zinc placed within a cylinder of platinum of equal diameter. Hence we conclude that the area of the efficient section of the liquid is the mean of that of the opposed faces of the metals.

The conclusion was again tested by measuring A by the chemical results produced, instead of the calorific, and substituting copper for the conducting metal instead of platinum. The amalgamated zinc rods and cylinders were weighed before and after each experiment, and the consumption of metal was thus ascertained for intervals of half an hour, during which the circuits were closed. The results are included in the following table:—

TABLE XLIII.

Diameter of Zinc.	Diameter of Copper.	Loss of Zinc in thirty minutes.
inches.	inches.	grs.
½	2¾	30
2¾		30
½	5½	29·7
5½	½	30

These results perfectly accord with the preceding.

From the consideration of the foregoing experiments, we are led to another important relation of the generating and conducting metals in these cylindrical arrangements; to understand which it must be borne in mind that the surfaces of cylinders, of equal heights, are directly proportioned to their radii.

Let us, therefore, imagine an indefinitely small rod of a generating metal placed in the axis of a cylinder of conducting metal of a given diameter, filled with an active liquid; upon making contact of the two metals, a current would be established of a definite amount. The area of the mean section of the electrolyte would be the area of a cylinder placed half way between the cylinder and its axis, or half that of the cylinder; and it would be the same whether the generating or the conducting metal were the exterior of the two.

Now the amount of the current ought to be the same whatever might be the diameter of the exterior cylinder, for the resistance occasioned by increasing the depth of the electrolyte, that is to say, by increasing the radius of the cylinder, is exactly counterbalanced by the increased conducting power conferred by the increased area of the section of the electrolyte, and *vice versâ*. The results of the experiments confirm this conclusion; for upon reference to Table XLII. it will be seen that cylinders of 1½ inches and 2¾ inches diameter produced, under like circumstances, the same amount of current; and from Table XLIII. we learn that cylinders of 2¾ inches and 5½ inches diameter had equal influences.

Now, it is curious to observe how chemical affinity in all these experiments waits upon the conducting and collecting power. The strong attraction of zinc for (*oxysulphion*) the radicle of the aqueo-sulphuric acid is held in complete check till a passage is open for the circulation of the force and the transfer of the hydrogen; and its efficiency is entirely dependent upon the facility of the passage; for it must not be forgotten that a double effect indicated by the galvanometer implies a double solution of the zinc, and a double reduction of the copper, in the same time.

(*To be continued.*)

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1852—WILSON, M.D., F.R.S.E., George.

[Electricity and the Electric Telegraph; together with the Chemistry of the Stars and their Inhabitants. By George Wilson, M.D., F.R.S.E. London: Longman, Brown, Green, and Longmans, 1852.] Pamphlet.

1852—HARRIS, Sir W. Snow.

[Rudimentary Magnetism; being a concise exposition of the general principles of Magnetical Science and the purposes to which it has been applied. With Fifty-six illustrations. Part III. By Sir W. Snow Harris, F.R.S. &c. London; John Weale, 59, High Holborn. MDCCCLII.] 12mo. 186 pages. Woodcuts.

1852—MOIGNO, M. L' Abbé.

[Traité de Télégraphie Electrique, comprenant son histoire sa théorie, ses appareils, sa pratique, son avenir, sa legislation, précédé d'un Exposé de la Télégraphie en général et de Télégraphie Ancienne de jour et du nuit. Par M. L' Abbé Moigno, &c., &c. Avec Atlas de vingt-deux Planches Gravées en Taille Douce. Seconde edition entiérement refondue et completée. Paris: A. Fremck, Libraire Editeur, 67, Rue Richelieu. 1852.] 8vo., 632 pages.

1852—ALLEN, Z.

[Philosophy of the Mechanics of Nature and the Source and mode of action of Natural Motive Power. By Z. Allen. Illustrated with numerous woodcuts. New York: Appleton and Co., 200, Broadway. MDCCCLII.] Royal 8vo.

The whole of this work is devoted to electrical subjects.

1852—JONES, H. Bence, and Du Bois-Reymond.

[On Animal Electricity: being an abstract of the discoveries of Emile du Bois-Reymond, member of the Academy of Sciences of Berlin, &c. Edited by H. Bence Jones, M.D., A. M. Cantab, F.R.S., Physician to St. George's Hospital. London: John Churchill, Princes Street, Soho. MDCCCLII.] Small 8vo.

1852—JONES, Alexander.

[Historical Sketch of the Electric Telegraph, including its rise and progress in the United States. By Alexander Jones. New York: George P. Putnam, 10, Park Place. MDCCCLII.] 8vo. Woodcuts.

1852—MOIGNO, M. L' Abbé.

[Traité de Télégraphie Electrique. Par M. L' Abbé Moigno. Second Edition, entièrement refondue et completeé. Atlas de vingt-deux Planches Gravées en Taille Douce. Paris: A. Fremck, Libraire Editeur, 67, Rue Richelieu. 1852.] 8vo. Many illustrations.

1853—WALKER, William.

[The Magnetism of Ships and the Mariner's Compass; being a Rudimentary Exposition of the Induced Magnetism of Iron in Sea-going Ships and its action on the Compass in different latitudes, and under diversified circumstances. By William Walker, Commander, R.N., Examiner in Navigation and Seamanship. London: Piper Brothers, and Co., Paternoster Row, Charles Wilson (late Wilson and Norie), Leadenhall Street. 1853.] Small 8vo. Illustrated, 217 pages.

1853—HARRIS, Sir W. Snow.

[Rudimentary Electricity; being a concise exposition of the general principles of Electrical Science and the purposes for which it has been applied. By Sir. W. Snow Harris, F.R.S., &c. Third Edition, with considerable additions, including extracts from the Cavendish Papers. London: John Weale, 59, High Holborn. MDCCCLIII.] 12mo., illustrated. 160 pages.

1853—O' SHAUGHNESSY, W. B.

[The Electric Telegraph in British India; a Manual of Instructions for the subordinate officers, artificers and signallers employed in the department. By W. B. O' Shaughnessy, M.D., F.R.S., Surgeon, Bengal Army, Chief Superintendent of Telegraphs to the Hon. East India Company. London: Printed by order of the Court of Directors. 1853.] 12mo., cuts.

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1853—Du Moncel, Th.

[Considerations Nouvelles sur L' Electro-Magnetisme et ses Applications aux Electro-Moteurs. Par Th. Du Moncel. Prix 3 francs. Paris: Imprimerie de J. Claye et Cie., Rue St. Benoit, 7, 1853.] 8vo. 154 pages.

1853—Dering, G. E.

[Magnetism'; a Sketch of the History and Principles of the science and its various useful applications, including those of the Mariner's compass and Electric Telegraph: A Lecture delivered at the Hatfield Mutual Improvement Society, Jan. 31st, 1853. By C. E. Dering, Esq., of Locksleys. Published by request. Hertford: Printed by Stephen Austin, Fore Street. MDCCCLII.] Pam. 12mo., 85 pages.

1853—De La Rive, Aug.

[A Treatise on Electricity in Theory and Practice. By Aug. De La Rive, Ex-Professor in the Academy of Geneva, &c. Vol. 1. London: Longman, Brown, Green and Longmans. 1853.]

Royal 8vo., 3 vols. The last two of a later date. Translated from the French by Mr. Charles V. Walker. Numerous woodcuts. See 1856 and 1858.

1853—Gloesener, Michel.

[Recherches Sur la Télégraphie Electrique. Par Michel Gloesener, Docter en Sciences. Liege: H. Dessain, Imprimeur, Libraire, Place St. Lambert.] 8vo.

1853—Bakewell, F. C.

[Electric Science; its History, Phenomena and Applications. By F. C. Bakewell, Author of "Natural Evidence of a Future Life," Inventor of the Copying Telegraph, &c., &c. London: Ingram, Cooke and Co. 1853.] Demi 8vo.

1853—Turnbull, Laurence.

[The Electro-Magnetic Telegraph: with an historical account of its rise, progress, and present condition; also practical suggestions in regard to insulation, and protection from the effects of lightning; together with an appendix containlng several important telegraphic decisions and laws. By Laurence Turnbull, M.D., Lecturer on Technical Chemistry at the Franklin Institute of the State of Pennsylvania. Second Edition, revised and improved. Illustrated by numerous engravings. Philadelphia: A. Hart (late Carey and Hart.) 1853.] 8vo., woodcuts and plates.

1853—Turnbull, Laurence, M.D., and Highton, Edward, C.E.

[History of the Invention of the Electric Telegraph. Abridged from the works of Laurence Turnbull, M.D., and Edward Highton, C.E., with remarks on Royal E. House's American Printing Telegraph, and the claims of Samuel F. B. Morse as an inventor. New York: Wm. C. Bryant and Co., Printers, 41, Nassau Street, Corner Liberty. 1853.] Pam., 10mo.

1853—Hogg, Jabez.

[Elements of Natural Philosophy; being an introduction to the Study of the Physical Sciences: Embracing Animal Mechanics, Pneumatics, Hydrostatics, Acoustics, Optics, Caloric Electricity, Voltaism and Magnetism, &c. Illustrated. By Jabez Hogg, Surgeon, &c., &c. London: Ingram, Cooke and Co. 1853.] 8vo.

1853—Society for the Diffusion of Useful Knowledge.

[Companion to the Almanac or Year-Book of General Information for 1853. Charles Knight, 90, Fleet Street.] Small 8vo. Price 2s. 6d.

Contains an article on "Electric Telegraphs."

THE INVENTOR'S INSTITUTE.

On Monday evening last, an ordinary meeting of the members of this Institute was held at the Polytechnic, 309, Regent Street. The chair was taken by Admiral Sir Edward Belcher, C.B., one of the Vice-Presidents. An able and comprehensive paper, reviewing the rise and progress of Submarine Telegraphy, especially as regards the various inventions used for the submergence of telegraph cables, was read by Captain J. H. Selwyn, R.N., who prefaced his remarks by expressing the pleasure he felt in bringing his paper before an assembly like that he saw around him, comprising as it did many having the highest reputation as inventors and men of science. He then adverted, in complimentary terms, to the great assistance afforded to the cause of science and the just claims of inventors by the gallant chairman, Sir Edward Belcher, who, though not a patentee, was the inventor of important and well known inventions. Captain Selwyn also adverted to the difficulties, chiefly nautical, which beset the laying of telegraphic cables generally, and quoted, on the authority of the President of the British Association, 1861–2, that three-fourths of all cables laid, or attempted to be laid, or 9,000 miles out of 12,000, are failures, involving an aggregate loss to the country of not less than a million and a half sterling, a result by no means surprising, when it was borne in mind that to this very day not a seaman sits on the consulting committee of the company for laying an Atlantic cable. Different inventions relating to the subject were critically passed in review, and their deficiencies pointed out, Captain Selwyn concluding his paper by suggesting means to remedy the defects to which he had called attention.

A discussion having ensued, in which Dr. Collyer, Mr. Hume Williams, and Mr. C. Varley took part, it was proposed, and unanimously agreed to, that the subject should be again brought forward at the next meeting of the Institute, on Monday, March 16, in order to give other inventors, who were desirous of expressing their views on the points raised by Captain Selwyn, an opportunity of speaking.

It was announced that the next subject for consideration is to be "Inventions for Obtaining Aërated Fresh Water from Salt Water," and will be introduced by Dr. Normandy.

Captain Selwyn's paper will be published *in extenso* in our next week's issue.

THE SERVING OF CABLES WITH HOT TAR.

As the Persian Gulf Cable is to be coated with a compound of hot tar and silica, the following extract from the evidence of Mr. R. A. Glass, of the firm of Messrs. Glass, Elliott, and Co., will be read with some interest at the present moment. The following question was put by Capt. Galton, the Chairman of the late Telegraph Committee of the Board of Trade:

"Do you find any difficulty arise from laying on the serving, saturated with hot tar?—Yes, we have found considerable difficulty in laying on the tar, as in the case of the Isle of Man cable, for this reason, that it will only adhere at a certain temperature, that temperature is nearly 250°, and we are obliged to be very cautious in the operation; and it occupies a great deal of time, inasmuch as the heat is so great upon the external wires that the gutta percha is liable to be injured. In fact, I may say that the gutta percha was injured in one case when we were laying it on in a particular way.

Professor Wheatstone.—By unsettling the wires?—By unsettling the copper wires in the centre of the gutta percha; the heat from the exterior caused the wire to leave the centre, and to come in contact with the serving.

Mr. Saward.—Are you now referring to the asphalted covering?—Yes.

Chairman.—Do you not consider that every plan by which heat is applied to the core after it is manufactured involves risk to the cable?—Decidedly."

Marriage by Telegraph.—The American papers assert, that a lady in Syracuse has been married to a soldier stationed at a fort near Washington, the two being 400 miles apart, and the vows spoken by telegraph; "it took two hours to do the work up complete, and the telegram from the chaplain to the lady, announcing that she and the soldier were man and wife, is the bride's marriage certificate."

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GOVERNMENT STATISTICAL REPORT ON ELECTRIC TELEGRAPHS FOR THE USE OF THE PUBLIC, IN THE UNITED KINGDOM, IN EACH OF THE YEARS 1859, 1860, AND 1861.

TELEGRAPH COMPANIES.	Length in Miles of Telegraph Lines.			Length in Miles of Wires Used.			Number of Stations open for the Public.		
	1859.	1860.	1861.	1859.	1860.	1861.	1859.	1860.	1861.
Electric and International*	6,272	6,541	6,727	31,346	32,148	32,787	428	476	772
British and Irish Magnetic†	3,719	3,768¾	3,903	16,595	16,661	17,043	382	386	401
South-Eastern Railway‡	308½	308½	309½	1,548½	2,087½	2,432	87	88	89
London, Brighton, and South Coast Railway ...	123½	162½	192	247	325	396½	29	30	35
London District§	—	73½	92½	—	335½	878¼	—	52	78
Total	10,423	10,854¼	11,223¾	49,736½	51,556¾	53,036¾	926	1,032	1,375
Submarine. (Telegraph to Calais, 24 miles; to Boulogne, 25 miles; to Dieppe, 78 miles; to Jersey, 80 miles; to Ostend, 70 miles; to Hanover, 280 miles; and to Denmark, 380 miles	—	—	887	—	—	2,484 Submarine.	—	—	474 in United Kingdom. and about 3,000 in Foreign Countries.

	Number of Instruments.			Number of Public Messages.		
	1859.	1860.	1861.	1859.	1860.	1861.
Electric and International	3,194	3,352	3,529	1,025,269	1,117,364	1,201,515
British and Irish Magnetic	923	1,073	1,084	549,880	608,332	689,738
South-Eastern Railway	129	133	135	43,156	48,897	55,085
London, Brighton, and South Coast Railway ...	92	114	131	11,425	14,664	21,680
London District	—	72	188	—	74,582	144,022
Total	4,338	4,744	5,067	1,629,730	1,863,839	2,112,040
Submarine	—	—	54 exclusively for Continental Traffic.	—	—	About 230,000 to and from Foreign Countries

TELEGRAPHIC PROGRESS.

THE half-yearly Reports of the various Companies, published in the two last numbers of THE ELECTRICIAN, will have been read with considerable satisfaction by all interested in the scientific and commercial development of our telegraphic system. In each case the Directors have had to announce an extension of traffic and an increased revenue. The Report of the Electric and International Telegraph Company states that, notwithstanding the numerous reductions in rates which have been made during the last twelve months, the buoyancy of the revenue continued unimpaired. The Company has considerably extended its lines in England, and, by the submersion of additional cables, the foreign traffic has been increased. The total amount of the Company's revenue for the half-year amounted to £117,074, exceeding that of the corresponding half-year in 1861 by £6,000, enabling the Directors to declare a dividend of £3 10s. per cent. for the half-year, leaving a surplus of £5,052 to be added to the trust fund. The total amount of mileage in actual operation is 7,597 miles of line, 35,066 miles of wire, 4,003 instruments.

The Chairman, the Honourable ROBERT GRIMSTON, observed at the meeting, with reference to the reductions in their tariff—"The Directors, did not regret having taken that step, as it was, he believed, a wise one, and not adopted until after it had been fully deliberated upon; and it would, he hoped, be the means of placing the business of the Company on a broad and sound basis." We trust that the success which has rewarded these timely reductions on the part of the parent Company will lead to further modifications in the present system of telegraphic communication, so as to extend its advantages more generally amongst all classes of the community.

For the first time, another Company presents an account of its operations for public scrutiny—The Universal Private Telegraph Company. This Company, as its name implies, is exclusively employed in constructing and maintaining private lines of telegraphy. Its operations extend to the Metropolis, and to several of the great northern towns. The Directors have declared a dividend of 5 per cent. upon the capital of the Company.

The Report of the Directors of the Mediterranean Extension Company, for the half-year, is very satisfactory, showing considerable increase of revenue. A new cable between Marsala, in Sicily, and Cape Carbonara, in Sardinia, has recently been successfully submerged. It is to be regretted that the working of the Malta and Alexandria line was not leased or entrusted to this Company, the public in that case would have had an

* On 31st December, 1861, this Company had 123 agreements with Railway Companies and with Public Offices for the transmission of their Business Messages. The number of such Messages is not precisely recorded, but is estimated as amounting to three times the number of Messages sent by the general public. This Company had, on the same date, contracts for supplying intelligence to 175 Journals, and to 99 Institutions, but no record is kept of the exact extent of the matter transmitted. It is, however, estimated that this intelligence, in addition to the Continental work passing over the Company's Submarine Cables, amounted, at the date referred to, to a total of 756,485 Messages.

† The number of Messages to and from the Continent transmitted jointly by this Company and the Submarine Telegraph Company, and the number of Messages for Railway Companies, Newspapers, and News Rooms, are not included with the Messages for the Public, but are estimated at about 250,000 Messages per annum.

‡ The South-Eastern Railway Company has no working arrangements with either of the Electric Telegraph Companies.

§ Exclusive of private telegraphs provided by this Company for Firms and Persons having two places of business.

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opportunity of knowing something about its operations. We find in the Company's balance sheet the following item in reduction of their expenses:—"Deduct Alexandria lessees' proportion of the Malta office expenses for half-year to 31st December, 1862, £264 4s. 1d." We should be glad to have a few more items relating to the Malta and Alexandria cables.

The London District Telegraph Company has published its Report for the half-year. The progress of this Company is highly interesting, as showing the increased appreciation of the advantage of telegraphy by the inhabitants of the Metropolis. We re-insert the table, showing the high ratio of the increase of messages over that in the increase in the number of stations:—

Year.	Net Receipts.			No of Messages.	Stations open.
	£	s.	d.		
1860	1,609	19	1	73,480	52
1861	4,729	17	5	142,724	77
1862	7,955	7	10	251,548	84

The Company, during the half-year, have effected several improvements and renewals upon their lines. In addition to a few contracts for private telegraphs, the Company has erected telegraphs between several of the stations belonging to the London Fire Brigade.

The British and Irish Magnetic Telegraph Company, the Submarine Telegraph Company, and the United Kingdom Telegraph Company have not yet favoured us with their reports; however, we are informed that the Companies' operations during the past half-year have been very satisfactory.

We insert, in another portion of THE ELECTRICIAN, an interesting document, lately issued by the Statistical Department of the Board of Trade. It will enable our readers to see at a glance the rapid progress of Electro Telegraphy during a period of three years.

The exportation of telegraphic materials from England to all parts abroad is rapidly increasing; for instance, the value of iron wire alone exported during the year 1861 was £214,441; in 1862, £321,044, showing an increase of £106,603.

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Dull Market.

Para First Quality	... 2s. 0d.	per lb.
Second „	... 1s 7d. to 1s. 10d.	„
Negro	... 1s. 1d. to 1s. 3d.	„
Java	... 1s. 5d. to 1s. 6d.	„

GUTTA PERCHA.

Very Firm Market.

Fine	... 2s. 6d. and above.	
Genuine	... 1s. 9d. to 2s. 3d.	per lb.
Reboiled good	... 1s. 7d. to 2s. 0d.	„
Inferior Reboiled	... 1s. 0d.	„

March 4, 1863.

WM. KIRKMANN,

4, *Howford Buildings, Fenchurch Street, E.C.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

HAWORTH'S TELEGRAPH.

To the Editor of THE ELECTRICIAN.

SIR,—I ask leave to offer a few observations in reply to a letter from Mr. Varley in your last impression.

I regret that Mr. Varley's experiments have proved unsuccessful; but this does not surprise me, as, if I read his letter correctly, he did not follow Mr. Haworth's specification closely—if, indeed, at all. It would seem that he constructed only *parts* of the apparatus, and did not even connect those parts in the manner prescribed in the specification.

I have seen Mr. Haworth's apparatus at work repeatedly, and have myself read off from the indicator the messages which have arrived—and these "irregular currents mistaken for signals" have consisted of words and sentences transmitted as correctly as by the electric telegraph. My house has been one station, and Brighton, or Kingstown, in Ireland, the other.

I can certify that the delay in bringing out this discovery arises from causes over which Mr. Haworth has no control. Accident has injured his apparatus. He will be delighted to transmit signals across the Atlantic as soon as the necessary machinery is ready, but he considers—not unwisely—that it is most important to make success doubly sure by previous repeated tests and experiments.

I believe that Mr. Haworth will be ready in a short time to submit the working of his apparatus to the strictest scrutiny, and will be content to abide by the result—confident that such a test will indisputably prove that his discovery, though perhaps "unintelligible," nay, "impossible," being contrary to all known laws of electricity, and therefore highly improper, is nevertheless practicable, and capable of being applied to a "useful" purpose.

JAMES M. HOLT.

3, *Kensington Park Gardens East, W.*
March 2, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—Having noticed several statements in your late Numbers, condemnatory of Mr. Haworth's patent for telegraphing messages *without wires*, will you allow me to assure you that I have witnessed such experiments, and can vouch for their success.—Yours faithfully,

Manchester, March 2, 1863. LAW. HEYWORTH.

To the Editor of THE ELECTRICIAN.

SIR,—We think it due to our client Mr. John Haworth, the patentee of "An Improved Method of Conveying Telegraphic Messages without the Aid of any Artificial Conductor," to inform Mr. Varley, through the medium of your journal, that we have sent messages and received replies by means of his apparatus, and that to and from considerable distances.—Yours, obediently,

MASTERMAN AND UPFILL.

15, *Clifford's Inn, March* 4, 1863. Solicitors for the Patentee.

To the Editor of THE ELECTRICIAN.

SIR,—Will you kindly allow me space for a line in reply to Mr Varley? I never received his letter of the 27th of January, and am truly sorry for any apparent discourtesy on my part. I fear other letters have shared the same fate.

From Mr. Varley's account of his experiments I find several particulars in which there has been considerable misapprehension on his part; but I cannot spare the time—nor can I ask you for the space—to give further explanations. It certainly is a new feature in electricity, if the earth's currents alone can register words and sentences on the dial plate. I hope shortly to be able to convince the most sceptical by ocular demonstration. For the present I am content to wait, being anxious rather to perfect my discovery than to push it.—I am, sir, yours truly, JOHN HAWORTH.

March 3, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—As the Persian Gulf cable is now under contract, we may expect that before the close of this year England will be in telegraphic communication with India, the Indian system being completed to Rangoon; and as I observe an influential deputation has had an interview with the Chancellor of the Exchequer to ask the Government for assistance in laying a line from Rangoon to Singapore, Java, and China, it may not, perhaps, be premature to consider the route which should be taken in order to connect the Australian colonies with the Anglo-Indian line.

Several schemes have been made public, but Mr. Gisborne's proposal for a cable round the coast, from East Java to Moreton Bay, a distance of 3,024 knots, has been more fully discussed, and has the merit of being more feasible, to a certain extent, than either of the other submarine lines projected.

Now, as Mr. M'Donall Stuart has again successfully crossed the Australian continent (as is well known), reaching the Indian Ocean, and planting a flag a little to the eastward of Cape Hotham, returning by the same route without difficulty, and reporting as favourably as ever of the

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major part of the country, which he has now traversed three years consecutively, I think it is worthy of consideration whether a direct overland line would not be practicable, commencing at a point on the north coast, nearest the Island of Timor, and passing through Central Australia, thus connecting the sea line with the various systems now in operation.

Mr. Stuart reports that the country is being speedily occupied, and it is stated that stations could be placed within comparatively short and workable distances, in a good pastoral country, with cattle run attached, which would induce persons of the required intelligence to accept the charge, at a moderate remuneration, of keeping the line in working order.

The length of this land section might be some 1,400 to 1,500 miles. The sea line from East Java, *viâ* Coepang, to the point on the north coast alluded to, about 940, giving a total of about 2,400 miles.

This is the shortest and most direct route that has been proposed, and as the geographical knowledge, which has resulted from Mr. Stuart's exploration, tends to prove the practicability of carrying out the line indicated, I hope it will receive that attention which it appears to be entitled to, when Mr. Stuart's journal comes on for reading at the Royal Geographical Society, which, I observe, is fixed for the 9th inst.—I am, &c.,

March 3, 1863. W. B. Passmore.

To the Editor of The Electrician.

Sir,—Your correspondent, R. S. Culley, refers to the mathematical law that to work a battery most efficiently, or, in other words, to get the greatest amount of force out of given materials, the internal resistance should about equal that of the external work to be performed.

The law may be true and its application quite legitimate in some telegraphic operations, but certainly not in the way assumed by M. Minotto for signalling through telegraphic circuits generally.

The line between Alexandria and Benghasi, with a resistance of about 4,000 units, is well worked with 15 cells of about 100 units internal resistance; but to cut up these into 500 elements, with an internal resistance of 4,000 units, would be a pitiful and stupid mistake.—Yours truly,

S. E. Phillips.

To the Editor of The Electrician.

Sir,—Ever obedient to the counsel of superior wisdom, I have struck out the expletive "adequate" from the text in Mr. Laming's essay, but still I cannot think that Mr. Laming believes what the text so altered implies, viz., that he can find the same quantity of electricity conducted in the same time by a single length of wire and by a wire composed of any number of such lengths joined together; the source remaining the same in both cases. Will Mr. Laming kindly inform me what description of battery and line wire will produce these phenomena, since in such an arrangement a single cell would as readily transmit signals across the Atlantic as it would deflect a galvanometer on the study table.

Mr. Laming, it appears, does not quite comprehend my principal objection to the theory he has advanced; but since he has kindly undertaken to remove such objections, I beg to repeat that the theory has been brought forward in connection with, and is supposed to be illustrated by, an analogy which is as far opposed to the known laws of hydraulics as the "theory" itself is in opposition to the known laws of Dynamic Electricity—and, in removing this objection, it must be borne in mind that a somewhat more legitimate sequence will be required than that adopted at page 192 of your present number, or at least, one more within the range of probability. A mathematician could not confound addition with multiplication, upon such grounds, for he would be no mathematician if he did, hence there is a contradiction in terms implied by the case as put, and the same reasoning is equally applicable to the case of the "Civil Engineer." I trust, however, that Mr. Laming will get beyond "what might be," in his next, and clearly explain how he happens to be at the present time in such antagonism to facts,—I am, sir, yours respectfully, Relay Magnet.

London, March 3, 1863.

TELEGRAPHIC PROSPECTS.

To the Editor of The Electrician.

Sir,—After a long depression, telegraphic enterprise is day by day assuming a more promising and vigorous attitude. Numerous deputations from time to time have waited upon her Majesty's ministers, old projects have been revived under favourable auspices, and new ones received with favour, but alas! another wail is heard. Is Her Majesty's Government going again to repeat what threatens to be one of those monstrous failures which have characterised its efforts as a telegraph constructor? It has been decided to submerge a cable in the far East, of which very few indeed would approve. It will have an *untried* conductor, an *untried* insulator, and an *untried* sheathing. Is there a practical electrician in Europe, besides those consulted by the Indian Board, who would approve of the conductor? Is there a chemist who would approve of the insulator, or is there a sailor who would approve of the cable? I opine not. We have here the practical suggestions of Stephenson, Fairbairn, Galton, and Wheatstone, set at defiance, the knowledge and experience of the Royal Commission ignored, and the rapidly increasing confidence in submarine telegraphy jeopardised. If the Electrician wishes to prove itself worthy of the name it has adopted, let it not look calmly on, when submarine telegraphy is in danger.

One who Pays.

To the Editor of The Electrician.

Sir,—The samples of the gutta percha covering of wire, perforated through and through by marine animalcules, referred to in my note to the editor of the *Society of Arts Journal*, may possibly still be seen by the curious, at the office of Messrs. Forde and Jenkins, engineers and electricians.

They were shown to me by my cousin, the late Lionel Gisborne, formerly a partner with Mr. Forde, and, to my mind, were conclusive evidence as to the certain destructibility of gutta percha by marine insects.

I beg, in conclusion, to state that I am neither directly nor indirectly connected with the advocates of either india rubber or gutta percha, but I believe that, so far, the advocates of caoutchouc have maintained their ground experimentally, and would hold their own practically,—I am, sir, your obedient servant, F. N. Gisborne.

March 2, 1863.

To the Editor of The Electrician.

Sir,—In your last week's report of the discussion which took place at the Society of Arts, on February 11th, Mr. Varley is stated to have said, "that the cable from Spezzia to Corsica, laid in 1854, was at this moment in perfect working order, and had never cost a farthing for repairs."

As I was sole engineer to this cable, which was made under my direct personal superintendence, and with materials (in respect to copper and gutta percha) far less perfect than those used in the construction of the many cables since laid, and now useless, perhaps a few words' description of some of the care taken in its formation may not be objected to. Each of the six separately insulated conductors in this cable, consisted of a copper wire, of No. 16 gauge, and though carefully selected, and generally capable of stretching one foot in four without breaking, there were spots in the wire perhaps, not an eighth of an inch in length, where it was quite brittle, the consequence was, that in making the first part of the rope, frequent breakage of continuity in one or other of the six wires took place, and to find out the situation of each such fault, the old system of pricking through the gutta percha covering was at first much used, but this system was, I felt, so dangerous, that I constructed a detector with six dials and a bell, which was always in circuit, and which gave notice directly any breakage in either of the copper wire conductors took place, and indicated which it was, the machinery was then immediately stopped and kept so until the fault was found out and repaired. Another point of extreme importance was the taking great care in connecting together the lengths of insulated wire supplied by the Gutta Percha Company—instead of the bell-hanger's joints, said to have been found in the Atlantic cable, the ends of the copper wires were flattened, lapped, and soldered together, and the joint then sewed with fine copper wire, wound spirally, one end of which fine wire should be soldered to the copper wire on one side of the joint, and the other end of the spiral to the No. 16 wire on the other side of the joint, so that in case of breakage (at the joint) of the No. 16 wires, the fine wire might still connect the ends. The next process, that of covering the joint with gutta percha, is a point of such importance, and so often a cause of failure, that only most trustworthy and first-class operators should be allowed to perform it, and such joints should be made so far in advance of the machinery for laying the hemp, or covering with wire, that they can be kept for a considerable time in water, to test their soundness before they are covered. There are many other points to which I might call attention, but I fear to take up too much of your valuable space; but what I wish to impress, is, that if a cable has been laid, and has kept perfect for nearly ten years, constructed with the most important materials, namely copper wire and gutta percha, avowedly very inferior, the first, in flexibility and conduction; the second, in purity and insulating power, it must be evident that the Atlantic Telegraph Company will far more consult their interests by themselves selecting and employing competent, practical, and trustworthy persons, to superintend and see to the construction in detail, of each portion of their cable, than by paying large sums for the partial services of any persons, whose avowed theoretical knowledge of electricity may be more boldly and frequently brought before public attention than that of others,—I am, &c.

H. V. Physick.

38, *North Bank, Regent's Park.*

TAR AND VEGETABLE FIBRES UNDER PRESSURE.

To the Editor of The Electrician.

Sir,—In reply to Capt. Selwyn's inquiry, whether there existed in the water of the pressure tank after the operation, any traces of tar? I beg to state that after the application of pressure, the water was found strongly impregnated with tar, as evidenced by its odour and taste. Fresh water being placed in the tank, upon the second application of pressure the water was not nearly so strongly impregnated with the tar. I procured a fresh piece of the tarred hempen strand from the Rangoon cable, and inserted it in the pipe (I had measured its tensile strength previously to its being placed in), the pressure was applied, and kept up for some days and nights. The weather at the period was very warm, and when the pressure was removed

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and the water allowed to run out, the odour of the latter was exceedingly offensive, so much so, that I was very glad to make my escape.

I had fresh water again introduced into the pipes, and the pressure kept up for some days—the water was tolerably free from smell, and upon examining the tarred strand, it was my impression at the time, that the salts and the more active spirits of the tar had been absorbed during the first period of pressure, and that what remained was an insoluble resin. My experiments, upon the whole, on the the conduct of tar in combination with hemp, under excessive pressure, is not favourable to its adoption alone for deep-sea cables. As to the effect of the pressure upon the fibre of the tarred hemp, treated as above described, I have already stated in a previous letter, that I was unable to detect any loss of tensile strength. I think, however, that it is of the greatest importance that the experiments should be repeated.

In testing tarred-hemp, spirally covered cables, such as the proposed Rangoon cable, for tensile strength, I found that as the tension increased the tar was squeezed out of the hempen strand in large quantites, and appeared in the shape of large globules upon the surface of the cable.

It would be very desirable to ascertain the conditions of the hemp and tar in the Agiers and Toulon cable, which I believe is about to be raised for repairing in deep water,—I am, &c., Owen Rowland.

Telegraphic News.

THE SUBMARINE TELEGRAPH COMPANY.

The half-yearly meeting of this company was held on Tuesday, at the London Tavern; Sir James Carmichael, Bart., in the chair, when the reports and accounts were submitted to the proprietors, by which it appeared that during the past year 172,881 messages had been transmitted, against 137,714 for the previous six months, showing an increase of 35,167 messages; that the receipts were 23,427*l.* 5s. 6½d., against 18,517*l.* 18s. 8½d., or an increase of 4,909*l.* 6s. 10d. That the proportion of earnings, after paving working expenses and repairs to cables, left a profit of 9,500*l.* 16s. 7½d.. and deducting the interest paid on debentures and loans, and 1,853*l.* 18s. 11d., being 10*l.* per cent. on the gross receipts for the reserve fund, there remained a sum of 5,285*l.* 0s. 3½d., equivalent to a dividend of 5 per cent. or thereabouts, per annum, on the share capital.

The Chairman, in moving the adoption of the report and accounts, and the recommendation to pay the dividend, expressed his views that the prospects of the company were very much brighter, and congratulated the proprietors that the suspense account was now cleared off, and that, notwithstanding the severe storms of last winter, from which four of their cables had sustained more or less injury, still they were in a position to declare a dividend.

Considerable discussion then ensued as to the propriety of declaring a dividend while certain liabilities of the company were outstanding; but explanations having been offered by the chairman as to the several points mooted, and information afforded as to various valuable concessions to the company,—

The report and accounts were adopted; and upon the recommendation to declare a dividend, a resolution was passed, "That the payment of a dividend be adjourned to a future day, to be named by the directors, being the day on which they proposed to call a special general meeting."

After the usual vote of thanks to the chairman, the meeting separated.

Our readers will regret to hear that Mr. W. F. Cooke, the energetic pioneer, in conjunction with Professor Wheatstone, of our great system of telegraphy, has been suffering for a considerable time from severe indisposition, at his seat in North Wales.

The Shah of Persia has decided upon establishing telegraphic communication between Teheran and Baydad, and thus to connect his capital with the European system of telegraphs. A line between Teheran and Boushyr is also in contemplation.

THE ACCIDENT TO THE ALGERIAN CABLE.

Subsequently to the violent storms that occurred in the Mediterranean during the nights of the 24th and 25th of November, the telegraphic communication established between France and Algeria by means of the submarine cable, was found to be interrupted. The telegraphic authorities took immediate measures to ascertain the cause of the accident. For this object the steamer Brandon was placed at the service of the minister of marine. A telegraphic inspector was sent to ascertain its state, and to commence his inquiries as soon as the state of the sea would permit.

On the 30th November, and the 1st, 2nd, and 3rd of December, many miles were raised and examined, commencing at Port Vendres, the point where the cable left the French coast. No damage was found in that part. The Brandon then started for the Balearic Isle, near which the cable passes; it was hoped that communication might be established between Algiers and Port Mahon, which, as we know, is joined to Barcelona by another cable. The stormy state of the sea interrupted the operation several times. It was necessary to search for the cable by dragging; for the buoy which had been anchored to mark its position near Port Mahon had been carried away by the storms on the nights of the 24th and 25th of November. At last, on the 27th December, the cable was brought on board the Brandon and cut. The communication with Port Mahon was very good, that with Algiers impossible. On the 28th and 29th, several miles of the cable were raised on the Algerian coast without finding the fault, but the depth becoming too great, it was necessary to abandon this operation for fear of breaking the cable, which has only a very weak covering of steel wire covered with tarred hemp.

During the intervals of these researches, after the violent tempests that lasted from the 12th to the 14th of December on the French coast, the electric resistance of the cable, which was tested every day, fell from 1250 to 80 *kilometres*. These observations led to the supposition that other fresh accidents had occurred on this coast, or that the conductors damaged by the first storm had been completely exposed by the second. The Brandon then sailed for Algiers, where she arrived on the 3rd of January.

The thick shore end was so much embedded in the sand, that it was found exceedingly difficult to raise it. Divers had to be employed to disengage it, and men furnished with cork jackets. It was in a perfect state.

Afterwards several miles of the cable were raised, but as the depths of the sea increased very rapidly, and as the steel wires of the covering were frequently broken, it was necessary to stop without finding the fault, which, however, appeared to be not very far off. The telegraphic administration afterwards treated for the English ship Hawthorn, which had just been employed by Messrs. Glass Elliott & Co. in submerging a cable at Cagliari in Sicily, and which had all the special appliances necessary for raising cables from great depths. This ship will continue the operation which the Brandon was compelled to abandon, and we expect that in a few days the communication will be re-established between Algiers and France.—*Annales Télégraphiques. January–February*, 1863,

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A Deputation connected with the Anglo-Australian and China telegraph, in reference especially to the portion of the line between India and Australia, *viâ* Java, had an interview with the Chancellor of the Exchequer on the 27th ult., at his official residence in Downing-street. The deputation was introduced by Sir Charles Nicholson, Bart., and consisted of the following gentlemen:—Lord A. Churchill, M.P., Sir Stuart Donaldson, Sir Henry Young, Messrs. R. Brooks, M.P., H. C. E. Childers, M.P., R. W. Crawford, M.P., T. W. Evans, M.P., J. C. Ewart, M.P., John Laird, M.P., W. S. Lindsay, M.P., Captain Bagot, L. H. Bayley, Charles Bell, R. Campbell, J. H. Challis, J. E. Coleman, J. J. Cummins, F H. Dutton, C. H. Ebden, P. W. Flower, Gisborne, H. C. Forde, Fleeming Jenkin, E. Hamilton, J. M'Arthur, Matthews (of Messrs. Grindlay and Co.), J. Youl, and Adolphus Young.

A Deputation on behalf of the British Electric Telegraph Company, consisting of Mr. J. C. Ewart, M.P., Mr. Edward Cropper, Mr. David Webster, Mr. C. K. Dyer, Mr. Edward Johnstone, and Mr. Edward Bright, had an interview with the Right Hon. T. Milner Gibson and the Right Hon. W. Hutt, on Thursday, at the office of the Board of Trade.

THE ATLANTIC TELEGRAPH COMPANY.

The deputation which has for some time represented the above important undertaking in the great commercial and manufacturing towns of the north, reports favourably on the results of its labours. The accession of shareholders has been such as to encourage the directors to persevere with redoubled energy in their efforts to secure the success of the undertaking. The numerous and valuable improvements in conducting and insulating materials, and the experience acquired in the science of telegraphy generally augur well for the future, especially as the directors have pledged themselves to secure the best practical advice and experience in the manufacture and submersion of the cable. A single cable in working existence between Europe and America during the last two years, would have, by this time, repaid a considerable amount of the capital invested, and yielded a handsome dividend besides.

A TELEGRAPH THROUGH CENTRAL AUSTRALIA.

From an important communication in our present issue, under the signature of Mr. W. B. Passmore, it appears that there is considerable probability that a direct overland line from the Gulf of Carpentaria to Melbourne will be adopted in preference to the submarine line, round the coast of the Australian continent, proposed by the Anglo-Australian and China Telegraph Company.

Miscellanea.

The phenomena of phosphorescence are well known to accompany many chemical changes. These have recently been studied by Reichenbach, who shows that phosphorescence, or the continuous emission of light in darkness, is a much more common occurrence than it is generally supposed to be. Thus there is phosphorescence during fermentation or putrefaction, crystallization, evaporation, condensation of vapours, the production of sound, and the fusion of ice; a considerable glow is remarked

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when a galvanic pile in activity, a block of ice undergoing fusion, or a solution of sulphate of soda in the act of crystallizing, are observed in the dark. The human body itself is not devoid of phosphorescence; in a healthy state it emits a yellow glow, whilst in ill health the colour of the light assumes a reddish tinge. To perceive these phenomena, the eye ought to have been previously rendered sensitive by remaining for some hours in perfect darkness, and even then all eyes are not equally impressionable; if, however, several persons unite in performing the experiment together, there will always be a certain number who are able to perceive the phenomena. Those of our readers who remember the strange announcement made by Reichenbach some years ago, of the existence of a new force in nature, which he termed the odylic force, and have not forgotten the incredulity with which his statements were received, will be disposed to accept any similar observations *cum grano salis*. It must not, however, be forgotten that the propounder of these strange theories is one of the first chemists and physicists of the day, and his researches in this "occult" science are as much characterized by philosophical acumen as his chemical experiments.

Some interesting experiments have lately been made by M. Maumené, Professor of Chemistry at Rheims, on the aëration of wines by different gases. Ordinary effervescing wine owes its sparkling qualities to the presence of carbonic acid gas, produced by fermentation, and dissolved in the liquid under a pressure of five or six atmospheres. The cork being removed, the greater portion of the gas escapes, communicating to the wine its much-admired sparkling qualities. M. Maumené has prepared wines by forcing oxygen gas into them under a pressure of seven or eight atmospheres. The wine, when sufficiently old, undergoes no chemical change, even when kept saturated with condensed oxygen for more than a year, and the preparation of the oxygenated liquid is a matter of no difficulty. Wine thus prepared is much more sparkling, or foams more than ordinary champagne. When a bottle is opened it disengages pure oxygen, which rekindles the red-hot spark of a blown-out taper. The taste of the wine is not changed, but it produces, after being drank, a sensible warmth, like the better kinds of old wine, and a general and well-marked agreeable sensation. The employment for some days of oxygenated water as a beverage, produces an improvement in the functions of respiration and digestion. A curious result is obtained by charging wine with protoxide of nitrogen (laughing gas), instead of oxygen. The liquid so charged possesses, in a high degree, the power of producing the hilarious effects attributed to the gas itself, it having been found that it was only necessary to drink half a glass of wine, previously saturated with protoxide of nitrogen, at a pressure of six atmospheres, to produce the transitory intoxicating effects attending an inhalation of laughing gas. It is not improbable, that the powerful stimulating properties of oxygen gas, or protoxide of nitrogen, might be of considerable medicinal value, if administered in the convenient form of a daily glass of aërated wine.

The Telegraph from Washington to California.—President Lincoln's last message was telegraphed across the continent of America, from Washington to California, a distance of 3,000 miles. The *Sacramento Weekly Union* says:—"Having received a Philadelphia journal containing a copy of the President's message we have carefully compared the text with our telegraphic report, and have been unable to discover more than two or three unimportant errors, not a line of the original is missing, nor was the sense changed in a single instance; and considering the length of the document, and the peculiarities of the President's style, the telegraphic report was a wonderful success."

Electric Express.—M. Bonelli, the re-inventor of Bain's (Bakewell's) copying telegraph, suggests a new application of electricity for the transmission of letters, light parcels, &c. A series of coils of insulated wire are adjusted along the route, and through them runs a pair of rails, upon which travels the wagon which carries the dispatch box. The wagon also carries an electric battery, and the ends of the coils are so adjusted, that the battery connection is made by means of the wheels and rails, through the coil that is just about to enter. As the wagon is of sheet-iron, it will be attracted to the centre of the coil, and the momentum which it acquires will carry it far enough to make the connection through the next coil, when the impulse is renewed. This contrivance will make a very pretty philosophical toy or piece of illustrative apparatus; but can it be economically applied on a practical scale?—*Cosmos*.

Guy's Electro-motive Engine.—Mr. G. M. Guy has described to the British Association his Electro-motive Engine. The author explained the difficulty of obtaining, by any of the methods heretofore suggested, a sufficiently rapid motion within the small spaces through which magnets or electro-magnets acted with sufficient energy, and chiefly in consequence of the rapid diminution of that energy as the distance of the poles increased, even by very minute quantities. He exhibited and explained a working model of an engine, in which—by the rotation of a cone of soft iron with a very obtuse angle, caused to roll on successive radial bars, arranged in a plane by the engine itself, when set in motion, caused to be successively electro-magnets with alternately attractive and repelling poles—an axle attached to the bore of the cone by a Hook's joint was made to assume a direct rapid rotatory motion, from which the required power could be taken off in the well-known modes. This engine had no dead points, and therefore required no fly-wheel.—*Timb's Handbook of Facts*.

To Correspondents.

B. R. Mills.—It cannot be admitted that electricity "moves spirally along a conductor;" but it may be shown that its passage produces "lines of magnetic force" in planes at right angles to the direction of the current, and the phenomena you seek to explain may thus be accounted for. Bearing in mind that a coil of wire, when traversed by a current, is virtually a magnet, the open sides of the coil forming the poles, and that a bar of soft iron placed at right angles to a conducting wire becomes magnetic, you will have little difficulty in modifying your ideas in accordance with the established theory. In some of our former numbers, under the heading "The Student," you will find this subject treated.

J. R. O.—At certain periods, especially during a dense fog, manifestations of atmospheric electricity, often of a startling and somewhat dangerous character, may be obtained by means of a rod of iron, elevated upon a house even of but two stories. A lightning conductor, connected to earth as usual, but with an arrangement to interrupt the metallic contact, so as to cause the electricity to traverse a short space of air, is the apparatus best adapted for the purpose you have in view. Even with this, however, great caution is sometimes necessary. The plan we should recommend for obtaining constant indications of changes in the electrical condition of the atmosphere is based upon inductive action—the electrometer becoming charged, not by conduction of electricity from the atmosphere, but by induced electricity. Place the instrument at any convenient elevation in the open air, and having adjusted it and brought it to the electrical tension of the earth by contact with the finger or otherwise, the needle will diverge when any increase or decrease takes place in the atmospheric tension. If you construct your own porous vessels, we recommend the following simple plan:—Procure a mandril or cylinder of boxwood of the size intended for the interior of the jar, and with a hole drilled through the axis. Upon this mould some common white clay as dry as it can conveniently be used, moisten the external portion, shape the mass by rolling, &c., and carefully withdraw the mandril. Dry the vessel thoroughly by exposure to a moderate heat for three or four hours, and then keep at a full red heat for half an hour or more. Excellent porous jars of any desired size may thus be made, which will withstand the action of nitric acid or any other exciting fluid used in the battery.

Archimedes.—The addition of spirits of turpentine, with the application of heat, might produce the required effect. The plan we generally adopt to obtain thin sheets of insulating material is to saturate cartridge paper with white wax, and varnish several times on both sides with shellac varnish. The process, though effective, is somewhat tedious.

M. D.—We believe that the only locality in England where aluminium is manufactured is at the works of Messrs. Bell Brothers, Newcastle-upon-Tyne.

The hemp should be first thoroughly dried of its moisture before its being saturated with tar—the tar otherwise by confining the watery vapour or sap will hasten the corruption of the fibres.

R. M. L.—A very beautiful and efficient instrument for measuring the resistance of copper wire has been contrived by Messrs. Elliott Brothers, and which promises to become into extensive use amongst electricians. It is a modification of the well known Wheatstone's bridge.

Enquirer.—A description of Captain Selwyn's apparatus for submerging submarine cables appeared in No. 30 of the Electrician. We would rather abide by the opinions of nautical men as to the applicability of the apparatus for the purpose in view than to the opinion of any of the gentlemen you refer to. We have not yet been so fortunate in the laying of deep-sea line as to justify us in pooh-poohing any suggestion which experience may bring before us.

J. Herman.—In the "Encyclopædia Britannica," published in the year 1771 page 447 it is stated that it had been discovered "that the motion of the electrical matter was so amazingly swift, that it ran over a space of 12,000 feet in an indefinable instant of time."

P. L.—Pine and fir trees have remained as inflammable as ever, although buried in the earth for centuries, and these trees have often been found to contain between the wood and the bark a "plain resin," the oil having evaporated. The resin of amber do not putrify or decay like other bodies. Amber resin may therefore remain unchanged for centuries in the earth or in the sea.

E. F., E. T. Co., Exeter.—We cannot imagine for what purpose the voltaic combination you mention (consisting of a vessel of lead, to contain a plate of zinc and one of copper connected by metal) could have been constructed. If used as a (primary) voltaic cell, it would realize the conditions for obtaining the greatest expenditure of material with the minimum of effect; and though it would doubtless be efficient as a *secondary* cell, the copper plate in this case appears obviously unnecessary and detrimental. If you wish to use it as a secondary combination, charge with dilute sulphuric acid, attach the zinc-copper element to the zinc pole of a battery of 5 or 6 Daniell's, and the lead element to the copper pole. In from 5 to 15 minutes it will probably be fully charged. We shall shortly have occasion to refer to a new construction of battery for the electric light.

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The Electrician.

Vol. III. No. 71.—March 13, 1863.

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THE ELECTRIC ILLUMINATIONS.

During several days of the present week, but little thought or attention has been given to aught save the celebration of the marriage of the heir apparent of the British throne. We may be excused therefore for referring to the universal topic, insomuch as it happens to be in connection with our usual subject matter. It is not too much to assert that the event which has just given occasion to so much public rejoicing would have lost some portion of its interest and splendour had the telegraph not been in existence almost hourly to send to Her Majesty and to the press its tidings of the progress to our shores, and through the kingdom and its capital, of the young Princess in whom we recognize our future Queen; and if the electric light had not added to the splendour of the festivities in which night was transformed into day. Nevertheless we must confess that we were somewhat disappointed with the results obtained on the 10th instant by the employment of the electric agency. At the Cathedral of St. Paul, where the most favourable opportunity for its exhibition was to be found, Mr. Pepper failed in producing anything like a grand and striking effect. Where we should have had an artificial sun, splendent at the summit of the great dome, and where the whole body of the magnificent edifice should have been brought into full relief, we could observe but a few straggling beams of light reflected into space from the interior of the ball upon the dome, or illuminating a small portion only of the structure. We think that the arrangement under which these results were obtained was essentially defective. The parabolic reflectors attached to the electric lamps of M. Serrin might with great advantage have been dispensed with in the case of the lights exhibited on the dome of the cathedral; and, if the illumination from the premises of Mr. Alderman Dakin had been directed upon the *facades* of the surrounding houses, the effect of the reflection from the latter upon the cathedral would have far surpassed the flickering and inconstant light directly projected at intervals from the reflector. It is stated that the cost of the *experiments* at St. Paul's amounts to about £200; and three batteries, each of 40 cells of Grove, were employed to light the western front of the dome. With this *matériel* and expenditure, something more than a very imperfectly arranged experiment should have been exhibited to the public.

At the Monument on Fish Street Hill, Mr. W. Ladd was more successful, and the effect produced was somewhat striking. Here no reflectors were used, and the lights were therefore fully visible from every point. These lights were five in number; that at the top of the ball of fire being equal in power to the four others, placed at the corners of the gallery. The lamp which produced the former was that of Professor Holmes, which many of our readers may have seen at the late International Exhibition; while the four smaller stars were produced with apparatus of Mr. Ladd's own construction. The total number of cells employed was 420 of Grove's.

The Nelson Monument was for some period brilliantly illuminated by the electric and lime lights, from the summit of the National Gallery. A very beautiful effect was produced upon the fountains in Trafalgar Square by means of a system introduced by Messrs. Defries and Sons, gas engineers; the water being made to reflect all the colours of the solar spectrum.

ON THE LAWS OF ELECTRICITY IN MOTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from p. 206.)

I believe I am neither mistaking my position nor unconscious of the necessity for supporting it by evidence, both of which are alleged against me. I leave the Editor to justify his views upon the subject, and I will offer him a justification of my own.

According to my belief, there are three modes of affording proof; 1st, The mathematical, which is unquestionable when, and only when, the data are so, and that in the mixed sciences is generally not the case. 2ndly, Observation by the senses in their normal condition, and which also is indubitable, but only when the narrative is confined to the thing actually observed, and not extended by reasoning to other things. And, 3rdly, Inductive inference, the validity of which is estimated by the judgment, and essentially depends upon a full observation of the facts upon which we have to reason. Now, of these three modes the second is by far the least comprehensive in its scope, and, in all inquiries into physical causes and effects must be helped by both the others. Neither of these am I neglecting in this discussion.

The Editor is, I believe, well read in chemistry, and, of course understands that chemists differ in their views of the constitution of compounds. Take, for example, ammonia; is it, as is commonly represented, NH_3, or, as Dr. Kane supposes, NH_2, H, or, again, as would seem to follow from Sir H. Davy's celebrated experiments, NH_4, O? Is the bicarbonate of ammonia to be viewed as $(NH_3, 2CO_2, 2HO)$ or, in conformity to Professor Graham's beautiful and comprehensive theory of basic water, as $(HO, CO_2 + NH_4O, CO_2)$? We cannot tell, but this we know,—none of the authors of those theories has yet been publicly warned that unless he prove all the theories but his own to be inconsistent with the facts they profess to embrace, his own shall not be deemed worthy of discussion. And have we not had in electricity theories of a single and of a two-fold fluid as competitors for supremacy? But which of them has ever yet been called upon to show by experimental evidence the incompetency of the other? The truth is that our reason penetrates deeper into the natures of things than our senses, and afterwards points to things in our facts until then unknown to be there, teaching us *how* to learn from observation by the senses, and bidding us, when we put constructions upon facts, to regard that theory as the most probable which is most in accordance with all else that we know. My friend will, therefore, perceive that I am justified in declining to disprove by mere experimental evidence any other system to make way for my own.

He has, however, intimated such an alternative as I feel to be, as he says, incumbent upon me to accept; I am now quite ready to defend my own theory, and to repeat the process so often as he shall supply me out of his own knowledge with facts that seem in opposition to it. He has called upon me "to test *three equal resistances* of thick wire, fine wire, and of both combined," and he tells me I shall "find that the quantity of electricity conducted by any one of the three wires will be precisely the same as that which will traverse the others with the same battery." I will assume that he means Ohmic resistances, and their equality to be determined by calculation; about which, however, he has left me room to doubt.* Now, with regard to

* In the experiment we have recommended to Mr. Laming, the three "equal resistances" should be obtained by electrical measurement upon Wheatstone's parallelogram,—they may then be measured by rule and compass to determine whether their equality be in accordance with theoretical formulæ. Let a given length of fine wire be inserted, at s.s., in the side A N of the parallelogram (p. 145, vol. iii.) and, at s's', insert a length of thicker wire sufficient to bring to zero the needle of the galvanometer (G),—which will have been deflected by completing the circuit through PA, AN and PB, BA, AN. The

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wires that are cylindrical throughout their entire lengths, I should find the results he has mentioned if the calculations were based upon my own definitions; for the battery being given, then the *conductivity* of a wire is in proportion to its sectional area, and the velocity of motion is in proportion to the *motive tension*, both that and the *intensity* being given with the battery. The *conductivity* multiplied into the *velocity* gives the *quantity* of electricity passing into, or out of, the conductor in an unit of time.

But the *motive tension* experiences *resistance*, which for each unit of *quantity* passing is as the length of the wire, and therefore, for all the units of *quantity* passing at any one time, as the square of the length of the wire. The product of the *conductivity* and the *velocity*, then, has to be divided by the square of the length of the wire; and thus will be deduced the *signalling power*. Now, we can make the length of a thick wire just so much greater than that of a thin one that their *signalling powers* shall be equal.

This is expressed algebraically by the following formula, in which P is the signalling power, S the sectional area, T the motive tension, and L the length of wire:

$$P = \frac{S \times T}{L^2}$$

It will be admitted that the view of physical causation afforded by these elements of calculation add to their intrinsic value.

With respect to the third wire, compounded of lengths of different diameters, the results of calculations founded upon the one hand upon Ohm's theory, and on the other hand upon my definitions *as given in the last* ELECTRICIAN, differ widely, and the question now before us is—Which of the two results is in accordance with fact? I wait to be informed whether the Editor *tested* for his three equal resistances, or obtained them in the manner I have assumed: and then I may have something more to say about this third wire.

The statement about high and low battery power imputed to me in the Editor's leading paragraph has evidently arisen from his misconceiving my meaning, and I need only disavow it; but I must notice the allusion made to the confident manner in which I am proceeding. It is asked whether I am not "guilty of an unjustifiable degree of temerity in questioning a result which is established by every experiment which has been tried in the laboratory and confirmed by all practical experience in testing the resistance of conductors." The most satisfactory answer that I could give to that question I have a motive for postponing a little while, but there is a substitute that I may in the mean time use for it. In years long past I had to struggle with a theory of electrical *repulsions* that was embraced by mathematical physicists, and said to be supported to a great extent by observation: though in the present day few philosophers ever speak of a force of electrical repulsion otherwise than as a mathematical myth unknown to the particles of matter. What might then have been characterised as unjustifiable temerity, the lapse of time has softened down into a well-grounded confidence. The Editor has been pleased to admit that in my published essays on electricity in its state of rest there seems to be the germ of truth; when he recollects that the electrical forces used in those essays to produce electrical action were in every instance, from first to last, traced from cause to effect by number and measure – that is, mathematically, though without the forms of algebra—and then takes into consideration that the forces which rule in static electricity are by the equivalent theory carried forward, by number and measure still, into the dynamic branch of the science; will he think the ground for dependence on my principles has been shaken since my earlier experience? I have more to tell him about them than he yet wots of, but I have a way of telling my own tale in my own fashion; and it will be no fault of mine if he misses any part of it from impatience.

He says, "Mr. Laming is at variance with ourselves upon a matter of fact." I cannot say I know precisely what that fact is, always bearing in mind the distinction between fact itself and the inferences drawn from it. I think I fully apprehend the meaning of the formula he recalls to my recollection, and I am aware that it is susceptible of any extension to cases abstractedly mathematical, but what I cannot perceive is, that it must necessarily be equally comprehensive of physical cases, seeing that it is not based upon universal physical principles. Franklin's attractive and repulsive forces, under the mathematical leadership of Epinus and Cavendish, were in harmony with nature up to a certain limit, but at the surfaces of bodies they had to call in the aid of an electrical atmospheric pressure, which was just as imaginary as the forces it had to serve, and far more difficult to be believed in. The same was true also of the celebrated mathematical antagonism of Poisson's two electricities; but, had either theory been based upon nature, can we doubt that it would ere this have met with a welcome like that with which the physically-founded theory of gravitation has been greeted, or the chemical equivalent theory of Dalton?

The Editor does not properly comprehend the grounds of my dissatisfaction with the theory of Ohm. I can with himself admire it as a piece of ingenious invention, and admit that, for certain practical purposes, it is calculated to be useful. But that, in my opinion, is not enough; for what is founded upon artifice cannot, even in its parallelism, follow nature everywhere; and in no particular will it lay open nature's *modus operandi*, without which, as physical philosophers, electro-telegraph engineers can never rest perfectly content.

With respect to the hydraulic analogy, said by the Editor to have been proved inaccurate by one of his correspondents, I have this week, in reply, exposed that gentleman's error. I am not answerable for the variable force with which the analogy was perplexed, and the introduction of which can only be accounted for by supposing it was believed that I meant something different to what I said. The hydraulics of the Editor, as he is applying them to the same analogy, need a separate notice; they have introduced to my mind an idea perfectly new, but which it cannot entertain. I know of no acceleration in velocity occurring between the piers of bridges or other obstructions that it is not referable to difference of levels and to momentum; although I have, many a time and oft "followed the tide of Thame in a small skiff," and, on one occasion, shot ahead of it with a very uncomfortable rapidity through the contracted central arch of Old London Bridge, leaving behind me a difference in water level of some six or eight feet, which, as I shall probably never forget, was remarkably perceptible! I need hardly say I did not stop to measure it, but I have no doubt of its being quite sufficient to account for all the acceleration in my velocity, without help from any mythic power that one might poetically imagine to have been lurking there for the occasion.

No one who knew Professor Daniell will speak of him without great respect, but it is no disparagement to say, that when he penned the sentiment expressing that in the voltaic circuit "chemical affinity *waits upon* the collecting and conducting power," he was both emulating the poet, and deep in the enjoyment of his well known stanza,—

"I'll take a flight,
* * * *
And leave dull earth behind me!"

That *waiting upon* is recommended to me as a fact; if it be one, then is it also a fact that water waits for opportunity to dribble into a full cistern in proportion to its leakage. The voltaic circuit must receive a much more circumstantial handling than that before I shall expect it to give up its physical mysteries; my hope is in new inductive inferences, founded upon the properties of particles, as derived from foregoing inductive inferences from facts,—a method of research which has never yet disappointed me.

sides of the parallelogram AN and BN will now be equal in their electrical resistance; and the inserted wire resistances will also be equal. For the thick wire, at s's', now substitute a wire compounded of lengths of wire of different diameters united by solder, and increase or diminish the length of this compound wire until the needle of the galvanometer again returns to zero. Three equal resistances will thus be obtained; and these, when tested with the same battery and indicating galvanometer, will invariably be found to conduct the same quantity of electricity—providing the conditions as to temperature, &c., remain the same.—ED. E.

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ON THE MEANS HITHERTO EMPLOYED FOR SUBMERGING TELEGRAPH CABLES.

BY CAPTAIN SELWYN, R.N.

READ BEFORE THE INVENTOR'S INSTITUTE, MARCH 2, 1868.

In this Institute of Inventors, seeing around me men who were inventors, and not only inventors, but benefactors of the human race before I was born, I confess I feel proud of the fact that however unworthily, I have first the honour of laying a paper before you, and that my name will hereafter appear as the foremost in bringing to what we may call the Inventor's Temple one of those offerings which I feel convinced will never fail of acceptation so long as they are brought with purity and earnestness of purpose.

What is invention? It is one of the chief means which the Creator employs to raise mankind towards himself. Inventors are His instruments for enlightening the human race. The Allwise Master Builder gives his workmen sharper tools, so soon and in such measure as he sees them wise enough not to misuse them.

The old masters of painting and sculpture, when they purposed the invention of a great work which they hoped to make a *chef d'œuvre*, prepared themselves for it by prayer and fasting. Let this be, if not our practice, at least our spirit, and He who give thus all things rightly to enjoy, will, even if we do not succeed in all our aims in this life, make us, after it is passed, to hear the blessed words, "Well done, good and faithful servant."

Hard indeed is too often the lot of the inventor in this world. Few are the cases in which society has not at first banned the mind through which it was blessed. Not even in the nineteenth century can the leading newspaper see or feel the inconsistency of publishing, with an inventor's printing press, the diatribe of an anonymous writer against an inventor's institute. That anonymous writer probably did not indeed use an inventor's steel pen to abuse inventors, for there is internal evidence that his letter was written with a goose-quill, but he has had the ill-luck and worse taste to advert in slighting language to a gallant admiral who happens to be known for many inventions, though not a single patent, but who excites the said writer's animosity because he gives the countenance of his ripe experience, great talent, and high station, to an endeavour to advance the just claims of inventors to their own,—claims which a certain portion of the public is ever seeking to evade or deny. Among the inventions of Sir E. Belcher, to which I refer, is, I believe, the anchor known as Trotman's or Porter's; this is said to be capable of proof by official records, and I should not be surprised to find that Q belongs to those "accessories after the fact" who profit by the spoliation of inventors, and therefore are anxious to enforce the assumed rights of their particular portion of the "public."

But shall we, for such as these, desist from invention? Shall we be even discouraged? The question is idle if asked of inventors alone. For the prophet of old, who could not desist from his prophecy, was not more constrained than is the inventor by the children of his brain, those thick coming thoughts which assail him at board or bed, which rise with him at morning dawn, and do not always permit him to seek peaceful rest at night. It is true, and cannot be gainsaid, that in order to the public benefit, it is necessary that inventors be protected. Paralysis would affect the inventor's brain if the public abstract the aliment intended to support its growth.

Forgive this digression. I appear here this evening a humble unit of the great body of inventors, to pass in review the various inventions which have been specially devoted to the laying or otherwise manipulating submarine telegraph cables; to comment on the various causes that may have led to the many failures which unfortunately blot our telegraphic records, and to lay before you the collective evidence on the subject, so far as I have been able to obtain it.

The importance of submarine telegraphic communication cannot easily be overrated, and no other enterprise promises in equal measure to benefit the thinking portion of the community, from among whom the members of such an institution as this will principally be drawn. For, the more rapid the communication of mind with mind, the sooner does ignorance yield place—the wider the spread of intellectual acquirements, the less is the field left for folly. Who has not seen the effect of a railway on a country town? Who has not traced the triumphs of the press? And if this be the case with comparatively slow methods of intercommunication, what will it not be, when, for the purposes of intellect at least, "there shall be no more sea." Whoever removes one stumbling-block from such a path does not lose his pains; to him who shall make the way plain, posterity, at least, will not grudge a noble place in the world's history. Let us to work then; first, to see what we ought not to do, and then we shall know better how to undertake our task with a fair prospect of success.

Failures, indeed, are not wanting in this instance to warn us. In 1861-62 the President of the British Association observes in his opening address that three-fourths of all the cables laid, or attempted to be laid, or 9,000 miles out of 12,000 are a failure and loss to the country. Since then, but few have been laid, and those principally in small depths, but more than one has been added to the list of failures. Now, this list of failures amounts in the aggregate to a loss of not less than a million and a half sterling. We have, indeed, seldom failed on so tremendous a scale,—you will say certainly there must have been some great mistakes; surely the men employed could not have known what they were about. I am not disposed to deny it. Let us examine what the mistake was, and at least attempt to save a repetition of it. First of all, to whom was the work committed? We all believe England to be the foremost maritime nation in the world; that her seamen are not, never have been, surpassed in their professional knowledge; that that professional knowledge infers the utmost command of expedients for performing any possible operation at sea, and of course we should naturally suppose that when the ocean was to be treated with, for the safe deposit of cables worth many hundreds of thousands, such a profession would be called upon to show its resources, to consider how the difficulty was to be overcome.

Not at all, to this very day not a seaman sits on the Consulting Committee of the Company for laying an Atlantic cable.

Who, then, were the men who undertook to solve this difficult question? What and who were the advisers? Engineers who had scarcely seen the sea; and electricans, some of them with very questionable diplomas, who had never handled a rope. Under such circumstances, can we wonder at failures? Ought we to have looked for success? Captain Maury has laid down that the most perfect theoretic conditions under which an Atlantic cable could be laid, would be that the ocean should be frozen, the cable laid across, and that then the ice should be thawed; and I see no reason to differ from him, but only to doubt the probability of our getting such an ice machine. Theoretically, of course, nothing could be more perfect; but we have to deal with possibilities, and to make as near an approach as we can to such perfection. I have seen an old wood-cut, in which is represented the first attempt of laying a cable, or wire, across water. There is a reel on the stern of the boat, which looks very temporary and clumsy, but it seems to have answered well enough for a short span and smooth water. But, *quantum mutatus ab illo*, reels of sufficient size to carry larger cables having been given up as impracticable for the stern or poop of a vessel, in came a host of engineers who, by brakes, drums, and all manner of contrivances, strove to get rid of the difficulty by going round that which they did not see their way through.

It is not my purpose to go into all the wonderful schemes which were invented and patented by men who must have, many of them, been utterly ignorant of hydrostatics, not to say of all the laws of natural philosophy; how one inventor recommended a big fishing rod over the stern, ignoring the rolling, which would be fatal; how another proposed to buoy the cable, as Mahomet's coffin is said to be in the air, between the surface and bottom of the ocean, forgetful of the fact of the increasing pressure of water in great depths, avoiding the difficulty that whatever cannot swim must sink. But there are some which, having been put forth and recommended by men of standing in the engineering profession, require more than a cursory notice, more reasons for their condemnation and failure than are patent to all at first sight.

A line which has often been cited as an instance of successful laying, is the one which, during the Crimean war, conveyed many important messages from the Government of England and France to their armies and fleets in the Black Sea. This was a simple gutta percha insulated wire, which was run out of a ship without any breaks, or apparently any great difficulty. It was coiled in the hold, and as it had no outer spiral wires it was not much exposed to the chance of kinks. It was passed through one or more boiler tubes; these were cut into by the soft gutta percha to such an extent as to necessitate the constant shifting of the tubes. I advert to this case principally because it has been assumed that as a cable or wire of this slight nature was laid successfully on this occasion, it could, therefore, be done in the same way in the depths of the Atlantic, and over the distance necessary for that line. This is a great mistake. The depth is a very serious element of danger, even with a light rope, as also the distance. In the Black Sea there is an average depth of 60 to 100 fathoms. In the Atlantic we have to deal with 1,500 and 2,000. In the Black Sea cable the length was 300 miles. In the Atlantic it must be nearly 2,000 at least by the central route.

But that to which I wish particularly to draw your attention, is the system of uncoiling pursued in this instance. It was the first occasion on which the cone and rings, invented by Mr. Newell, were used

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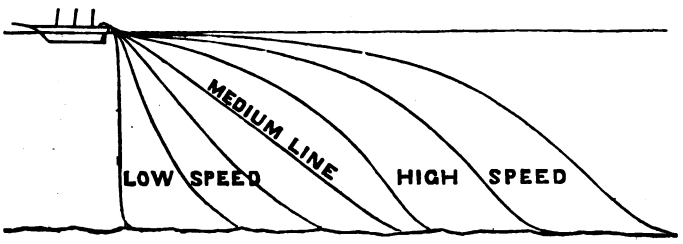
and they succeeded perfectly in getting the cable out of the hold without kinks. Whenever a long rope is coiled down on board a ship, if it be not a heavy one, and it is necessary to run it out quickly and clear (if, for instance, with 20 fathoms water the leadsman found it inconvenient to hold the whole of the line in his hand while swinging the lead, he would lay a portion of the coil on the place where he stands), the simple plan of avoiding kinks or fouling is to hold the hand over the centre of the coil, letting the line run through it. This is the principle, and, in a measure, the action of the cone and rings, the cable ought never to have been coiled down at all, but being in the hold, this is about the best way to get it *out* clear, but it may be carried into effect as well or better by leading blocks or pulleys of a certain construction, as by rings, and as for the cone, that is a thing the utility of which depends entirely upon the form and place of the coil. If cable layers insist on putting cables into water tanks, as I shall presently notice, I doubt much whether the cone could be usefully employed with the cable, or rather insulated telegraph wire, of which we are now speaking, no break appears to have been employed, and in the absence of currents transverse to the course, such a wire in such depths may always be as easily laid as it appears to have been on this occasion.

But if currents *do* exist, from whatever cause arising, whether a surface current, from a continued gale, or deeper movements of the ever fluctuating element, then in direct proportion to the lightness of the cable and its size is the danger of breakage or loss. There is an upward curve of light cables, and even comparatively heavy ones, whose operation is to expose a very considerable portion to the effect of a surface current, or any similar movement of the water lower down in a less degree. That curve and its modifications is shown in the diagram No. 1. It is caused partly by the difference between rate of



ships and rate of sinking of cable, partly by resistance of water to cutting descent. The rate of ships may vary, but the rate of sinking on any given cable must be invariable if unresisted, which of course it always would be, except under the most absolute necessity. That I may err, if at all, on the side which tells against my argument, I will assume that a deep-sea cable can sink at the same rate as a sounding lead. It will then take one hour in reaching bottom in a depth of two miles. But, if during that hour, the ship have gone over five miles of surface (and if she averaged less, she would take a long time to make the voyage) then the difference between five and two, or no less than three miles, will be laying along the surface exposed to current action, and in proof that this action will be a serious one, I will give a few figures:—

According to the experiments of Col. Beaufoy and others, the resistance of a cylinder in water is equal to 11·8lbs. per square foot, at a velocity of two knots, taking this as the force and rate of a current, and putting the diameter of cable at one inch, we have a force of no less than seven and a half tons on the three miles, exposed to such action. Here is the real reason against extremely light cables, for long stretches of deep sea. We may, indeed, seek to combat or reduce the danger, by going slowly, so as to allow the ships to have a rate of progress, equal only to the rate of sinking of cable, but in that case we linger longer in the danger, and increase the chance of its recurrence. I believe, on the contrary, that the only real remedy lies in getting on as fast as you can, and consenting to whatever loss of cable that may be inevitable. This will not be so much as might be feared, as the cable though taking a curve to leeward, will eventually sink on the path of the vessel over the ground, as distinguished from her intended course.

The next cable, the laying, or attempted laying, of which I propose to notice, is the old Atlantic. After much coiling back and forth, many accidents and shortcomings, it was at length fairly sent to sea, in the *Agamemnon* and *Niagara*, the latter vessel (an United States frigate), carried her portion much better than the *Agamemnon*, where it was necessarily not all stowed so low in the vessel; dead weight being always least objectionable when stowed low down in the ship. In this instance, most complicated machinery was put on board, which I have the best authority for saying, did not answer its purpose. Moveable platforms, as ships' decks must always be considered to be, do not permit of any certainty of action in such machinery, and if weights are employed to give or indicate pressure, they become heavier with the upward pitch, and lose in effective weight with the opposite motion. Men had to be stationed to keep the wheels in motion; and no seaman will fail to see the force of that passage in the report of the Committee on Cables, which points out in unmistakeable language the inutility of such an apparatus in a gale of wind. Then, again, the pitching of the vessel when her speed is brought down to near the sinking rate of cable, has a peculiar effect in causing kinks to be taken in under water, where the engineers cannot see them, and therefore think they do not occur; but as the cable cannot accommodate its rate of sinking to the velocity of downward pitch, it becomes partially waterborne; and kinks, if not breakage, are the result. I have not the smallest doubt that if the Atlantic cable had been as good as it is now discovered to have been bad, the system of laying pursued would have caused its failure, and that we cannot expect often to be so fortunate, if we send ships to sea loaded in such a manner, as ever to hear of them or their cargoes again. After the breaking down of the Atlantic, several cables were laid in various directions on short routes. The cable designed for a single stretch to Gibraltar, with an insufficient size of conductor for such a distance, was eventually laid in short sections between Malta and Alexandria. The Red Sea cable was, after being subjected to a treatment which, with gutta percha, was unexcusable, strained as tightly as it could be laid, in water of generally small depths; and shortly after broke down completely. The inference has been drawn from a moderate degree of success in laying short lines of heavy cable in shoal water, that the same process may be adapted to prove successful in longer lines, but a close examination into the conditions under which such partial success has been obtained, will, I believe, convince anyone that not a single difficulty has yet been overcome which formerly caused failure, and I fear that the Persian Gulf cable will furnish us with no proof to the contrary, constructed, as it is, in exact opposition to the dictates of experience. Intended to pass through the torrid zone, it is insulated with gutta percha and compound, and to be covered with asphalte. Designed after the error has been exposed, it is covered or to be covered with spiral iron wire. With the knowledge that the conductivity of copper is ruined by any extension after softening, it is redrawnand left unannealed to provide for a fanciful form of conductor. I shall be most happy to hear of its success, but I fear there is but little reason to expect it. If it is laid and does last, then no possible cable need be despaired of.

The brake employed for laying the Malta and Alexandria cable was of so peculiar a construction that I must devote a few words to it. Not that I have anything to say against its simplicity—simple enough it was, heaven knows, if it was designed to try how much the cable would bear in the way of bending before it would break. First of all it was coiled into a large circular tank which was kept, or intended to be kept, full of water. This is now said to be absolutely necessary, but I think most seamen will agree with me that to fill a cylinder or two almost as large in diameter as your ship and as high as her deck with water and cable, is certainly not a seaman's way of ballasting the vessel. Next it passed over a V sheave or pulley, after coming from under a sort of circular well lid, sliding up and down in the cylinder or water tank, then under a weighted or jockey pulley, ditto repeated, 4 turns round a drum, more V sheaves and pulleys with weights, and finally it *escaped* into the sea. I suppose when the ship rolled the weights danced—I am sure the cable should have danced for joy, when it got away from such treatment. But they had no bad weather and so they got safe to shore. I *have* heard that more than one of the engineers concerned acknowledge that if a storm had come they would have stood a fair chance of going with the cable to the bottom. I have no doubt even that would have been called a successful laying by some. This brake is one of those which I think may fairly be condemned even when considered as being used on a stable platform, which ought never to be the case with machinery devised for employment at sea. The brake devised by Mr. Longridge, whose mathematical knowledge has enabled him, like Mr. Gravatt, in most cases to arrive at theoretical conclusions which are fully borne out by practice, has, however, in the instance of the cone, this defect. It does not provide for the cutting action, which has been shown to exist even in the case of gutta percha against iron, and the frictional retardation which he proposed to gain by using a grooved cone for the cable to pass round would necessarily speedily destroy the groove. In the other system proposed by the same gentleman. in which two endless bands of wire-rope, faced with rubber and steel, revolve in contact, and press the cable between them; while admiring the ingenuity and simplicity of the mechanical

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arrangement, and its similarity to the action of the human hand, I fear that even the steel would be cut into grooves by the cable, and that if this, as I hope no cable again ever will be, were covered with iron wire spirally laid, these would be stripped from and become a source of danger to the insulator, yet it is the most reasonable of the many forms of brake proposed for use on board a ship. The one reason why no possible brake can be expected to be successful, is the mobility of the platform; and the fact that the velocity of the pitch of the vessel upward or downward, cannot be met or controlled in its effect on the suspended cable by such means. I will now, for a moment, recall what are the curves and their causes, to which a cable is liable during its deposition. First, the vertical curves, or the section of the ocean. Here the law obtains that when the speed of ship is less than that of sinking cable all the curves are catenary (but this is rarely the case with deep sea cables); secondly, that when (as is generally the case) the speed of ship is greater than the rate of sinking, all the curves are the reverse of catenary, or they are convex to the sea bottom. The first law also applies, I should say, when from the same depth the time occupied in reaching the bottom by the cable is materially lessened; this applies to shore ends and heavy cables. Whenever the catenary curve is in existence, from the slackened speed of ship, due, perhaps, to head winds, currents, &c., then a danger arises from the downward pitch of the vessel of taking in kinks under water. This is easily illustrated by a thread in water, the rise and fall of the hand holding the end of the thread imitating the action of the vessel in pitching. No danger from this source is to be apprehended during the existence of the upward curve. But, in that case, another, equally to be feared, comes into action, that of the current to which I have already alluded. I have purposely recurred to this part of my subject, in order to prove that no brake, however well applied, could eliminate these dangers; that we must seek the solution of these difficulties by doing away with the ship altogether. We must have some body which will float without being liable to pitching or rolling, which is, from its nature, a self-acting brake, and which will at all times take care of itself and its cable, if separated from the motive power for a time.

It has been said, that if the cable were light and flexible enough, it might be laid without any break; I have sufficiently shown, in the event of currents, why this is not the case. Not even in a perfectly motionless ocean, such as never existed, unless in a poet's brain—"the painted ship upon a painted sea," of Coleridge's "Ancient Mariner," could this be true. The weight of two miles of cable in water cannot fail to be at all times sensible enough, or to cause a velocity of motion which, in the case of a gutta-percha covered wire in the Black Sea, we have seen to be sufficient to cut through a boiler tube by continued friction, and this in comparatively small depths. Therefore, I maintain that it is equally mistaken to say, that we can do without brakes altogether, as to say that any brakes can be successfully applied on a moveable platform. Are we, therefore, to consider that we have become enclosed between the horns of a dilemma from which there is no escape? I trust not so. I hope to show that there is a middle course which will give safety; yet, before doing so, I must sum up as well as I can what has been proved or stated on the subject. It is an indubitable fact that wherever cables have been laid in the catenary curve, which has always been the case in shoal water, no great difficulties have been encountered other than the common occurrence of kinks due to coiling. That in no case has it been proved that the insulator was insufficient for its work, if not strained, mechanically injured, or subjected to heat, which it was never guaranteed to stand. That among the sources of mechanical injury, kinks are the most common form, and straining not unfrequent. That it is a gross mistake to consider spiral wires surrounding a comparatively soft body, as a "protecting arch," and that if these wires, as in the cable now constructing for the Persian Gulf, require external protection of asphalte, or some such mixture, we ought to consider for what earthly purpose they are valuable in a cable, whether, in fact, they are not absolutely and inevitably, sources of danger. It will be said: what would you have, you don't trust light cables, and you don't like iron wire, which makes heavy ones. I am prepared to answer, there is here also a safe middle road. The specific gravity of a deep-sea cable ought to be such as is necessary for the depths of route along which it is proposed to lay it. The maximum weight suspended in water ought never to be much greater or less than half the breaking strain. It must be provided that, whenever this is exceeded materially, the cable shall be freely given out. Engineers will, I know, say, our rule is one-fourth of the breaking strain as a constant load. True, but this is never a constant load, and if we make it lighter, we run into other not less serious dangers. They will ask, How about the pitching of the vessel? I answer, I will make a vessel that will not pitch, I never contracted to do the thing on the old system. As a seaman, I know that it could never have any certainty of success, but I can, and, *Deo volente*, will do it, if you will let a seaman's mind attempt the solution of a nautical difficulty. Having therefore reviewed, imperfectly I know,—for the time would fail me, and if not, I might fail for want of ability, the methods which have not answered, I now beg to bring to your notice an entirely different method, which I feel fully confident will answer, and as in this confidence I am supported by not a few engineers, as well as by some of the first men in my own profession, and as by a naval man who has for the last six years been engaged in laying cables, it has been pronounced to be the only "honestly safe method," I hope that I shall not be told that I have no grounds for believing that I am right.

There is one of the things which, I believe, I have not adverted to, but which I have considered, and which is perhaps worth mentioning now. That is, the inertia of a large mass weighing some 1,500 or 1,800 tons, and its effect on a cable. The reason why the cable will break in a ship from pitching, is the velocity generated in the upward pitch by the wave. It is shown in the diagram,* and results from the combined action there illustrated. This exists in a far less measure in a body like the cylinder, which has practically no length, and in this action is also shown how the effect of this motion is that in a given time a given amount of cable must be dragged out of the brakes, and this cannot be done, and therefore the cable breaks. But in the cylinder, as the motion is less, so the time during which it takes place is correspondingly increased, it has (that is) no more velocity of upward motion than the wave itself. This is known to be very moderate, and in that time it is quite possible for the cylinder to revolve in answer to the strain, the small increase of velocity required being unresisted by the paddles, which act the part of brakes in consequence of the law of resistance of water being as the cube or cube root of the velocity. Thus it has advantages in this respect which can never be possessed by a ship with brakes on board. The collateral advantages of generally being able to keep the cable in water, and under any circumstances not to endanger a vessel, as well as the cable, are not to be undervalued, and as the cylinder, built for experiment, can be usefully and economically employed for storing petroleum oil, if it were not found as well adapted, as I believe it to be, for telegraphic purposes, there seems little reason why the experiment, which of course would be necessary before proceeding to lay a cable, should not at once be entered upon.

Reference was then made to Captain Selwyn's system of laying cables, which has been fully described in our columns and in a pamphlet entitled "Explanation of the Floating Cylinders for Laying Submarine Cables."†

ALPHABETICAL LIST OF TELEGRAPH COMPANIES.

The Atlantic Telegraph Company.
Established 1856.
Secretary—George Saward, Esq.
Chief Office—22, Old Broad Street.

Length of Cable, 3,000 miles. In operation from the 5th of August to the 3rd of September, 1858—scarcely a month; during which time 366 messages, consisting of 3,942 words, were transmitted.

The British and Irish Magnetic Telegraph Company.
Established 1856.
Secretary—Edward B. Bright.
Chief Offices—Threadneedle Street, E.C., and Exchange Buildings, Liverpool.
Extent, 4,000 miles. Employs 1,500 officers.

Bonelli's Telegraph Company.
Secretary—
Chief Office—Lincoln's Inn Fields, W.C.

The Electric and International Telegraph Company.
Incorporated 1846.
Secretary—J. S. Fourdinier.
Chief Office—Telegraph Street, Moorgate Street, E.C.

* See p. 54, Vol. II.
† Published by T. Piper, Electrician Office, 32, Paternoster Row.

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Extent, 7,222 miles. Miles of wire employed, 34,255. Number of instruments, 3,719. Number of stations in Great Britain and Ireland, 841.

The London District Telegraph Company.

Secretary—Charles Curtoys.
Chief Office—Cannon Street, E.C.

Extent, 92¼ miles. Miles of wire, 378¼. Number of stations, 70.

The London and South of Ireland Direct Telegraph Company.*

Secretary—W. A. Travers Cummins, Esq.
Chief Office—7, Broad Street Buildings.

Extent, 454 miles.

The Mediterranean Extension Telegraph Company.

Secretary—Henry C. Orton.
Chief Office—Gresham House, Old Broad Street, E.C.

This Company's lines extend from Otranto to Corfu, and from Malta to Sicily, communicating with this country *viâ* Naples.

The Submarine Telegraph Company.

Established 1852.

Secretary—L. Walter Courtenay, Esq.
Chief Office—58, Threadneedle Street.

Extent, 887 miles. Average number of messages transmitted annually, 300,000. In communication with 3,000 continental stations.

Telegraph to India, incorporated with the Red Sea Telegraph Company.

Secretary—C. L. Peel, Esq.
Chief Office—65, Moorgate Street, E.C.

Extent—Land line, 1,000 miles; sea line, 1,440 miles; land and sea, 640. Total, 3,080 miles.

The United Kingdom Telegraph Company.

Secretary—W. Andrews, Esq.
Chief Office—237, Gresham House, Old Broad Street, E.C.

The Universal Private Telegraph Company.

Secretary—L. C. Herbert.
Chief Office—48, Strand.

The Victoria Telegraph Company.

Secretary—Charles Todd, Esq., Observer and Superintendent of Telegraphs.
Chief Office—Adelaide.

General Telegraph Works Company.

Secretary—James Henson.
Chief Office—215, Gresham House, Old Broad Street, E.C.

Telegraph mileage in Great Britain and Ireland ...	15,000
" " in other parts of Europe	80,000
" " in America.....	48,009
Total of land mileage of telegraphs.....	150,000

Yearly average of receipt for telegraphic communications, £350,000. —*Bond's Handbook of the Telegraph.*

* This Company is not now in existence.

FOREIGN PUBLICATIONS RELATING TO TELEGRAPHY.

PERIODICALS.

Annales Telegraphiques, publiées par un Comité composé de fonctionnaires de l'Administration des Lignes Télégraphiques. M. Dunod, Libraire des Corps Impériaux des Ponts et Chausées et des Mines, 49, Quai des Augustins, Paris.

Revista de Telegraphos, imprenta nacional, calle de la Reina, num, 8 duplicado, Madrid.

Zeitschrift des Deutsch-oesterreischischen telegraphenvereins, verlag von Ernst et Korn, Berlin.

Moniteur Telegraphique, guide-tarif des dépêches, publié avec le concours de l'Administration, Paris, Napoléon Chaix et C^ie^.

NEW BOOKS.

Manuel de Telegraphie Electrique, par L. Bréguet 4^e^ édition, revue, corrigée et augmentée. 1 vol. in-18 de 250 pages, orné de 80 gravures sur bois et de 4 blanches gravées sur acier. Hachette et C^ie^.

Expose des Applications de l'Electricite, par le comte Th. Du Moncel, revue des découvertes faites en 1859, 1860, 1861, et 1862. 1 vol. in -8° de 560 pages, avec planches et gravures intercalées dans le texte. Hachette ou Mallet-Bachelier. Prix: 10 francs.

Manuel des Chefs de Station et des employes de l'administration des Lignes Telegraphiques, par M. Etenaud, chef de. station au Puy (Haute-Loire). 1 vol. in-18 de 500 pages (*sous presse*). Prix: 5 francs. Chez l'auteur, au Puy.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Dull Market.

Para First Quality	2s. 0d.	per lb.
Second "	1s 7d. to 1s. 10d.	"
Negro	1s. 1d. to 1s. 3d.	"
Java	1s. 5d. to 1s. 6d.	"

Gutta Percha.

Very Firm Market.

Fine	2s. 6d. and above.	
Genuine	1s. 9d. to 2s. 3d.	per lb.
Reboiled good	1s. 7d. to 2s. 0d.	"
Inferior Reboiled	1s. 0d.	"

March 11, 1863.

Wm. Kirkmann,
4, Howford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	———	———
Stock	Electric Telegraph . .	100	99 to 102	———
5	London District Telegraph .	all	2 to 2¼	2⅛
10	Mediterranean Extension Tel.	all	3 to 4	———
1	Submarine Telegraph, scrip. .	all	¼ to ⅜	———
1	Do. registered . . .	all	———	———
Stock	Do. " . . .	all	———	———
2	Telegraph to India . .	1	⅞ to ⅝ dis.	———
5	United Kingdom Telegraph .	3	¼ dis. to par	———

Galvanic Batteries for Steamers.—The Emperor of the French is now superintending the construction of a battery intended to replace fuel. In this country it has been proposed to our Admiralty to make a trial of a galvanic battery of 2,000 double plates, each containing 36 square inches, the whole surface being 128,000 square inches. Charcoal points connected with the two poles are ignited to whiteness: on withdrawing the points from each other an arch of light 4 inches in length is produced between them. When any substance is introduced into this arch it instantly ignites.

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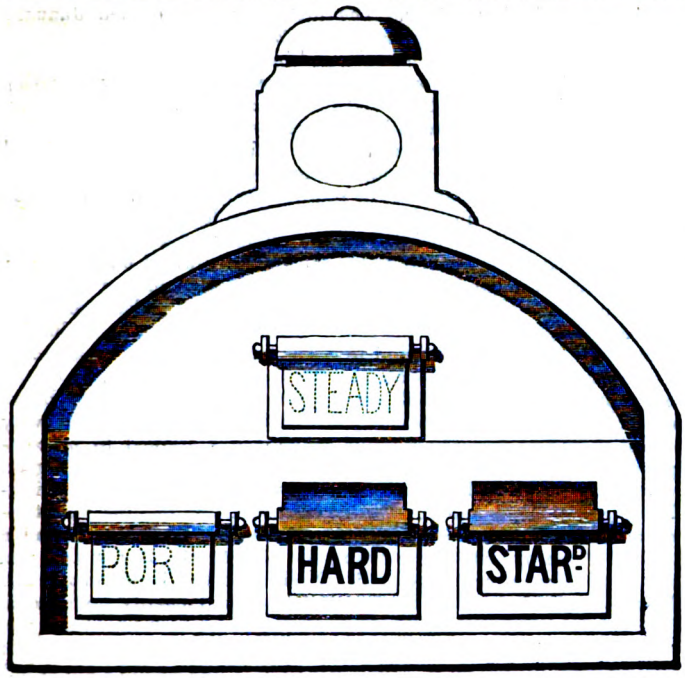

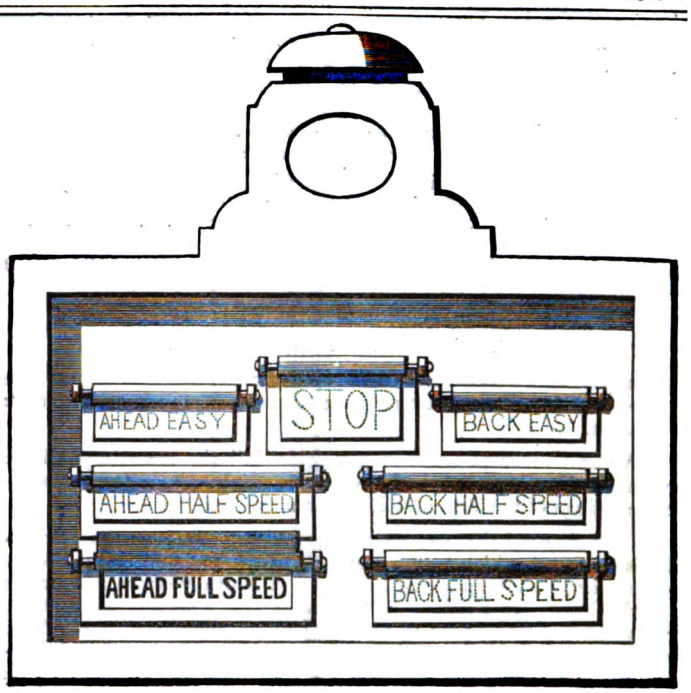

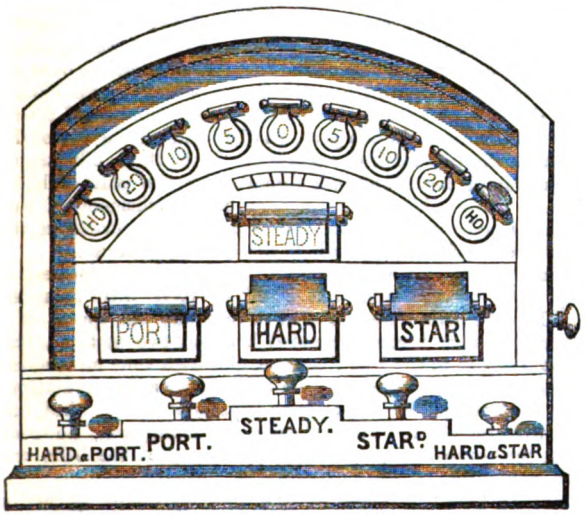

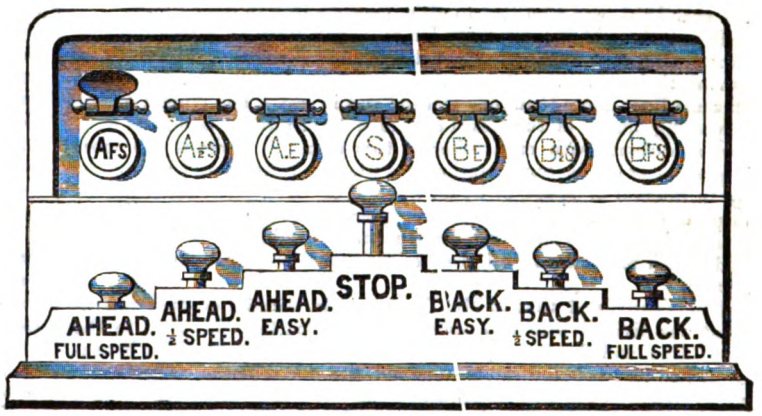

F. N. GISBORNE'S PATENT SHIP STEERING AND ENGINE ROOM SIGNALS.—1862.

The following description of Mr. F. N. Gisborne's patent ship telegraph has been communicated to us:—

In cases of imminent collision at sea, it is of the most urgent necessity that the helm be changed instantly, and in steamers that the engine be under the same immediate command. Also, that during intricate navigation, entering harbour, or in foggy and stormy weather, the captain's orders be conveyed quickly and unmistakeably to the helmsman and engineer;—that the replies be equally prompt and clear, and that the actual movement of the helm be made apparent to the commanding officer.

These important results, the patentee has effected in a manner at once simple, durable, and inexpensive.

Before the helmsman is placed a small box (containing a bell), upon the face of which are four metal flaps, and under which, upon enamelled glass, are painted the words Port, Steady, Starboard, and Hard, the last word being common to the orders "Port and Starboard," when required.

A lamp behind this instrument at night illuminates the words (when uncovered) upon their relative significant colours, *red* and *green*.

Between the helmsman and the wheel is a horizontal lever placed within easy reach of knee or thigh.

On the paddle-boxes, bridge, forecastle, or any one or more convenient places on the ship, are placed smaller instruments (similar to the helmsman's indicator, and in connection with the lever and the rudder head), which have five knobs or handles marked *Port*, *Starboard*, *Steady*, *Hard-a-Port*, and *Hard-a-Starboard*, in connection with the corresponding words before the helmsman.

In connection with the rudder head is a contact maker for the purpose of indicating, in degrees, the various movements of the helm.

In the cabin or hold is a simple form of galvanic battery, inexpensive to maintain and easily kept in order. It will remain permanently in action for twelve months without being touched, and is the only motive power used.

The instruments are then connected by a strong electric cable (each conductor being a strand of seven wires), which is secured out of sight under the deck beams.

A pressure upon any of the knobs by the commanding officer, or look-out, instantaneously causes the bell to strike, and the corresponding flap to fly up before the helmsman, who has thus the order given, in full view, just so long as the knob is pressed down, while a slight pressure upon either side of the lever instantly raises the corresponding flap on the Captain's instrument, thus correctly acknowledging the order sent.

At the same moment the helm shows its own altering position (independently of the helmsman), upon the small tell-tale dial face attached to the captain's indicator, thus, *before the alteration of the*

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rudder acts upon the ship's course, allowing ample time and opportunity to correct any possible error which the helmsman may make.

The engine-room signals are an adaptation of the above instruments.

The chief feature in this invention is its extreme simplicity, there being no wheel-works in any of the instruments, and no bearings, excepting the visible supports of the flaps.

An ordinary man can understand and repair them, if necessary, and the most uninformed seaman can master all details in five minutes.

The above apparatus can be applied to any ship or steamer, at moderate cost.

INSTITUTION OF CIVIL ENGINEERS.

DISCUSSION ON MR. PREECE'S PAPER "ON RAILWAY TELEGRAPHS AND THE APPLICATION OF ELECTRICITY TO THE SIGNALLING AND WORKING OF TRAINS.

[We have much pleasure in giving in full the recently published report of the discussion which took place at the above Institution on the evenings of the 20th and 27th January.]

It was observed that two statements had been made in the "Private Press" abstract, which required explanation. The first referred to the system introduced upon the London and North-Western line by Mr. Edwin Clark. In alluding to the use of disconnecting wires, it was remarked that "this plan was thought to be dangerous." By this it was not meant to be implied that danger was induced to the traffic of the line, but that the wires were liable to cause derangement in the electrical circuit. The second had reference to the instrument recently applied on the Metropolitan Railway by Mr. Spagnoletti, which, though identical in principle with one invented by Mr. Highton in the year 1854, was admitted to differ considerably in detail.

It was thought the necessity for an opportunity of discussing this subject would be apparent, when it was understood that no two lines, having their termini in London, employed the same system, and that on some lines, more than one method was in use. The reports of the inspecting officers of the Board of Trade upon railway accidents were also at variance with each other in this respect. Perhaps the most important point for consideration was whether lines should be worked by an interval of space, or by an interval of time. The Government inspectors recommended the former plan, while the managers of the principal railways contended that the traffic could not be carried on under such restrictions, and that reliance must be placed on the latter system.

It was explained that in Mr. Tyer's system the dial of such instrument was divided into two parts, the upper portion referring to the "up" line, and the lower portion to the "down" line. Each instrument had also two indicators—one red, the other black. The former always showed the last signal sent; the latter that last received, and this was unalterable by the man in charge. No signalman ever sounded his own bell or gong; and when these were heard the man knew that the next station wished to communicate with him. As regarded the effects of atmospheric electricity, it was asserted that it had never caused a false signal to be given; and as the red needles were altogether out of circuit, and could not, therefore, be affected by lightning, the chance of demagnetisation from this source was reduced one-half. Further, the needles were not permanent magnets, as in most other instruments, but simple pieces of soft iron, which received their magnetism by induction, from being suspended in close proximity to the coil of wire through which the charge flowed. As to the objection that this system only required one line wire, it was believed to be an element of safety as well as of economy; for, where two or more wires were employed, if one were broken, with persistent currents flowing through the fractured wire, or either of the others, false signals might pass into the instruments; whereas, with one wire, should it be broken, no signal could be acknowledged, and thus be made complete. As to the instruments being always under lock and key, it was argued that when any derangement occurred, it was safer to send for the superintendent at once than to allow the signalmen to attempt to repair, alter, or tamper with what they knew nothing about; and it was considered that all "terminals" and connections should be under lock and key, as a signalman might put the wires on to the wrong "terminals," which, with persistent currents and needle arrangements, would cause a different signal to be recorded at the distant station to that transmitted.

As the extensive system of telegraph train-signalling on the South-Eastern Railway—the basis of which was "sound upon bells"—had only been cursorily alluded to in the paper, it was considered advisable to give some further details. The first bells were erected January 22—31, 1852, and, at the present time, 275 miles of that line were protected in every possible manner, and in a great variety of places, by bells, there being 330 in operation, some connected merely in pairs, others with intermediate bells, and in different ways. Of these, eighty-four were provided with counting indexes, which showed the number of blows struck, and the remainder were plain. In some of the signal boxes there were two, three, and, in rare cases, as many as four bells, which differed in tone, and in the position they occupied. Should the signalman be uncertain which bell sounded, or how many blows had been struck, the index pointed to the number on a dial. It was a simple mechanism—a pair of pallets and a scape-wheel on the arbor, which carried the hand of the index to the precise number of blows struck upon the bell. The total cost on the whole line had amounted to nearly £3,650, being at the rate of £13 5*s.* 3*d.* per mile, including wires, bells, and batteries complete. The hammer, which was attached to the keeper of the electro-magnet, was the only movable part of the bell apparatus. The signals were given by the number of blows struck, and one fundamental and essential condition was that every signal should be correctly repeated before it was allowed to be complete. In every system of train signalling it was essential that a good understanding should be established between the men at two neighbouring stations, A and B. On the South-Eastern line the four telegrams which were necessary between them were—1st, "May I send a train?" given by station A striking one blow to B. 2nd, "Yes, you may," one blow struck back by B. Nothing could be simpler. The blow was a loud one, distinct in its sound, and readily understood. The third communication would be from B. 3rd, "The train you sent is in safe," intimated to A by three blows; to which the fourth message sent back from A, 4th, "All right, I understand train is in," A repeating B's three blows. These four signals were booked by each station; the time at which each signal was completed being entered in the proper column, so that a double permanent record was secured. On the three lines on the west side of the London viaduct, run over by the South-Eastern, the Brighton, and the Croydon and Crystal Palace trains, where the bells alone were used, the average number of trains on week-days was 196, and, in one year, 78,676; and on the day of the Foresters' Fête at the Crystal Palace, August 19th, 1862, 535 trains were booked as having been *bonâ fide* signalled by one pair of bells. It was satisfactory to be able to add, in proof of the efficiency of this system of train signalling, that no collisions had ever occurred on the portions of the South-Eastern line where the bells were in use.

One peculiarity about these instruments was that they appeared to be the only kind of telegraph that could be used with balanced currents. When the bells were arranged in this way the guard of a train, which might have become disabled between two stations, had merely to fasten a wire to the bell line-wire, and each time he touched a rail with the other end of the wire, the bells at the adjacent stations on both sides were rung. No batteries or apparatus of any kind had to be carried with the train. The system of signalling was, however, so efficient on the South-Eastern line that such a use of the bells was hardly to be looked for.

It was believed that the South-Eastern Railway Company carried out the "block" system of telegraph train-signalling to a greater extent than any other in the United Kingdom, and that, as it was the only system which could be followed with any degree of safety, especially where the trains were run at high speeds and at irregular intervals, to suit the emergency of the traffic, it ought to be made obligatory upon every railway company. On the other hand it was argued that, upon a main line of railway, the use of the "block" system would be disadvantageous, as being liable to lead to greater detentions than were called for upon any ground of public safety, and as having a tendency to lessen the caution necessary to be observed by engine drivers. Although there might be portions of a railway so crowded with traffic that the telegraph would become an essential element of safety, and where this system might answer very well, yet so long as its aid could be dispensed with there was a positive advantage in ignoring it, and in depending upon the ordinary mode of signalling; for the "block" system required such a greater number of signals and signalmen, as to increase the liability to mistake, and so render the alleged additional safety very questionable.

It was remarked, that both the ear and the eye were apt to be misled—the ear especially; and that as the continual and monotonous repetition of the same sound must have the effect of confusing the mind, the bell system could not be trusted. The eye, too, was liable to error, and the constant motion of the needles to produce weariness. It had been ascertained, that the best clerk in the Electric Telegraph Company's service made a mistake once in five thousand nine hundred and eighty times. Although in the simple work of signalling trains

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"in" and "out" the mistakes would be fewer in proportion, yet it was generally admitted that the electric telegraph was a dangerous instrument to trust, as the primary agent in the working of a railway. As an auxiliary, however, telegraph train signalling was believed to be invaluable, and its application indispensable; for it enabled managers to expedite, under extraordinary circumstances, the passage of trains, to economise time and money, and as a corrective of other signals, it was productive of increased safety.

The several instruments by means of which the "block" system could be carried out were then described. In reference to Mr. Tyer's instrument it was remarked, that although perhaps one wrong signal might be sent by a current of atmospheric electricity, yet no series of false signals could be transmitted, as might happen if the magnetism of a needle were reversed. In this system the batteries were not permanently closed, and the current was not kept constantly flowing through the wires; consequently the batteries did not deteriorate so rapidly as in those systems in which a permanent current was maintained. But this instrument had what might be considered a serious fault, for, to send one and the same signal, two different buttons had to be used at two different times, according to the position of the red pointer; and, if the wrong button were chosen, the needles showing the condition of the line would be altered when they ought not to be moved. In Mr. Preece's instrument there were several hinges, and at each there was a liability to stick. In addition there was a cog-wheel and rack, and the great motion of the semaphore arm, as compared with the small motion of the armature, placed the latter at such a disadvantageous leverage that the slightest check to the end of the semaphore arm would prevent the motion of the armature, whether moved by the current or by the weight, unless very powerful currents were had recourse to; and the utmost force caused by the electric current was very feeble. Moreover, the working parts were exposed to dust and dirt. It was thought that Mr. Walker's bell system, and other instruments which did not leave a permanent visible signal, threw too great a strain on the attention of the signalman. Mr. Edwin Clark's system, as in operation on the London and North-Western Railway, was believed to have few practical objections, and therefore to be safer, than any other. The instrument he employed was made of a common magnetised needle, balanced on two pivots. There was the least possible amount of friction to restrain the motion of the needle, the action was of the simplest kind, and the instrument was scarcely liable to be deranged.

It was urged that no system of mechanism intended for train signalling should be capable of being used for any other purpose. Also, that if the distances between the signal stations were made to correspond with the maximum amount of traffic likely to arise on any particular section of a line, the objection to the block system, that it unnecessarily delayed the traffic, would be at once removed. It was singular that, while it was attempted to ignore the advantage of the block system on the open line, its importance was admitted in tunnels, where the greatest caution was required. One great defect in all the systems previously noticed was that arising from the failing of the batteries. In Professor Wheatstone's arrangement of magnetic signals, as there was no voltaic battery there could be no diminution of power; so that the instruments would be as available twenty years hence as at the present time. They also possessed a great surplus of power beyond what was required for train signalling; and could be and had been arranged to give a large number of signals, in addition to the two simple ones of "train on line," or "line clear."

The ordinary station signals now in use gave three signals, "all clear," "danger," and "caution." As they were almost invariably maintained either at "danger" or at "caution" the latter signal was frequently taken to mean "all clear," and being thus disregarded, not only had it no value, but an element of danger was introduced. On the Great Western line, the "caution" signal was given by a policeman with his hand on peculiar occasions only, and when really required.

It had been ascertained by experience that the signalmen preferred the system of permanent signals to those in which the same wires were used for both lines of rails, and by which trains were simply "reported" as in or out of a tunnel. As an illustration it was mentioned that, at Springwood, near Huddersfield, where there were three cabins with telegraphs, so much impressed were the men with the necessity of having a permanent signal, that they invented one of their own, consisting of a piece of red rag placed on the instrument when there was a train in the tunnel, and removed when it was reported clear. This red rag had now been replaced by a card, Bells to indicate "line clear" or "line blocked" seemed more objectionable than the system of temporary needle signals, as the eye was more to be depended upon than the ear. The repetition of signals was the best safeguard against error, and against failure from demagnetisation, reversal and accident to the wire, or to the apparatus, from any cause.

It was remarked that the Metropolitan Railway was worked entirely by telegraph, the trains being controlled by station semaphores moved by the signalman. During the first three weeks it had been opened, more than half a million passengers had been conveyed over the line, and on one occasion the number amounted to nearly forty thousand within fifteen hours, and no mistake had occurred in the working. The instruments employed were the invention of Mr. Spagnoletti. In their normal condition, when not in action, or in case of derangement, neither signal was distinctly visible. The line was blocked by pressing a red key, when the disc at both stations showed the red colour, and the words "train on line." The colour indicated by the disc was always identical with that of the key upon which the finger was placed. The white disc signal was given for "line clear." Either could be seen from any part of the signal-box with a moderate light, and it was considered that the marked distinction offered by the broad discs of different colours (red and white) constituted of itself an advantage over the needle signal.

With regard to the working of single lines of railway, it was contended that the only system which would ensure absolute safety was the "train-staff." In the manipulation of the telegraph, one mistake might be fatal, whereas the "train staff" could scarcely go wrong, as to produce a collision there must be the consentaneous mistake of three men—the station master, who had charge of the staff, the guard, who received it from the station master, and the engine-driver, who could not move till the staff was produced. To this it was replied, that the "train-staff" system had been found by experience, in Ireland, to be exceedingly defective, as even when running only five trains per day in each direction, it was almost impossible to repair defects on the line without working in the night, or to run extra trains at times of fairs and markets. On the other hand, it was asserted that the "train-staff" had answered well in a great number of cases, both in England and Ireland, and that not a single accident had occurred, from trains meeting one another, where it was employed; whilst where telegraph instruments had been used without a "train-staff," there had been a number of accidents under various systems of working, in consequence of mistakes and misunderstanding on the part of the persons in charge of the instruments. In answer to this it was observed that the alleged inefficiency of the telegraph in the working of single lines was due, as far as could be ascertained, more to the eccentricity of genius on the part of the railway officials, than to the system itself when worked under proper guidance; inasmuch as in India about 2,000 miles of single lines (or considerably more than all the railways in Ireland put together) were worked by the telegraph with comparative freedom from accident. Thus, during the year 1860, out of 4,225,240 passengers carried in India, none had been killed from causes beyond their own control, while only 0·94 per million had been injured. According to the English returns for the past year, the passengers carried were 173,721,139, the number killed averaged 0·26 per million, and those injured 4·50 per million. Again, one-half of the accidents on English lines arose from collisions, while on the Indian railways, one-seventh only emanated from the same cause. Theoretically, no doubt, the "train-staff" led to greater safety than any other mode of working. But persons might be preserved from railway accidents by not going upon a railway at all; and the "train-staff" system was an approach to doing away with railway travelling. As a system it simply meant that, provided a company confined itself to one staff, it would also limit itself to one locomotive; and so long as only one locomotive ran upon a line there could not be any collision. But it was obvious that, under that system, trains could not be started from the same end of the line at short intervals of time, and therefore it was considered wholly inapplicable to any railway on which the traffic was large.

It was stated that, in the year 1854, Mr. C. V. Walker constructed a semaphore electric telegraph for train signals, which exactly coincided with that described by the author. It consisted of a galvanometer needle, with an ivory arm on the top of a semaphore pole, instead of an outer needle, a persistent current causing the arm to be retained in one of its positions. This instrument was used at Tunbridge for eight months, and was shown at the International Exhibition at Paris, in 1855. At the same time Mr. Tyer exhibited a pair of disc signals, coinciding in many points with the French plan of using discs. Experiments were tried on this latter system on the Paris and Strasburg line, and at present there were about 150 sets of these instruments at work on the Continent.

In reply upon the discussion, it was observed that the first great

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question was the advantage of the general adoption of the telegraph in the working of railways. Those who had spoken seemed to confirm the opinion expressed in the paper, that the telegraph was chiefly valuable as an auxiliary agent. Railway companies did not appear, at present, to have arrived at any definite conclusions as to the point of demarcation where it was necessary to abandon the "time" system, and to seek the aid of electrical signals. It having thus been determined that, in certain localities and under certain circumstances, a system of electrical signalling was essential, the question arose whether the telegraph was to be dependent upon the organs of sound, or upon those of sight. Although the South-Eastern, the London, Chatham, and Dover, and the North-Eastern Railway Companies employed bells, it was contended that the weight of the evidence was in favour of visual, as against aural signals. The next point for consideration was, whether these visible signals should be produced either in a permanent or in a transitory manner. As the use of transitory signals necessitated the employment of record books, it was believed that they were disadvantageous, as record books could never be trusted. In discussing the question, whether these permanent signals should be obtained by the use of continuous or by momentary currents of electricity, various natural and artificial phenomena were referred to, which disturbed the correct working of telegraphic circuits. The first and greatest enemy was atmospheric electricity, and its most frequent effect was one resulting from the inductive action of a cloud charged with electricity. Such effects were stated to be comparatively harmless on the semaphore, to be easily remedied upon the needles, but to be highly dangerous, as giving false signals, on Mr. Tyer's and other instruments worked by momentary currents. Deflections, or "earth currents," also seriously affected circuits worked by momentary currents. There were also interruptions arising from accidental and artificial causes, such as the wires coming into contact; these would produce false signals on instruments worked by momentary currents, while those actuated by continuous currents would remain unaffected.

With regard to the invention of the semaphore electric telegraph, it was remarked that both Mr. Walker and Mr. Preece had been anticipated by Mr. Ward, in 1847. And although the idea conveyed in the two instruments in question was similar, their mechanical construction was different; for Mr. Walker's was a simple needle, while Mr. Preece's was a practical railway signal. The author did not, however, claim the mere invention of the semaphore; but the assimilation of the electrical to the ordinary line signals of the particular railway upon which they might be fixed, the method by which electrical signals were simply worked as distant signals, and the reduction of the whole system to one uniform plan.

After the meeting a model of a railway brake was exhibited by Mr. W. G. Creamer, of New York. This plan was stated to embrace, first, an arrangement of compensating or balanced brakes, actuated by one lever, and distributing the pressure equally on all the wheels, with a small expenditure of power. Secondly, an attachment of reserved power to the brakes of every carriage, in combination with a non-elastic signal rope, so as to enable the driver instantly to apply every brake in case of danger; or on the separation of the train, or any part being thrown from the line, the brakes would apply themselves automatically, as each carriage was entirely independent of all the others, and the brakes were available wherever they were placed in the train.

OHM'S FORMULA.

(*From Daniell's "Introduction to Chemical Philosophy."*)

Before we proceed with the experimental investigation of our subject, let us pause a moment to observe how beautifully and simply the formula of Professor Ohm may be made to include and represent all the varying circumstances of current affinity and resistances which arise from the different combinations which we have examined: and how it indicates new conditions of the problems to be solved, and suggests new experiments to test their correctness. In making our comparison between the experimental and calculated results, we will take as our standard of comparison, one of the cylindrical cells of the constant battery just described, of 3½ inches in diameter and 6 inches in height, charged with dilute sulphuric acid and sulphate of copper, and the circuit closed by a short thick wire of copper, by which the exterior resistance r is virtually reduced to nothing.

It has been experimentally found that the amalgamated zinc rod forming the generating element of the arrangement when weighed at intervals of five minutes, loses 11.26 grains for every such interval. This is a measure of the effective force of the circuit; and its equivalent in mixed oxygen and hydrogen gases, as given off by the decomposition of the dilute acid, is 25 cubic inches. This may be taken as the unit of work or $\frac{E}{R}=1$, and it is evident that there being no external resistance, it is the maximum of work that such a combination is capable of performing. Now, having a number of such cells, all of course capable of performing the same amount of work in the same time, let us calculate the effects which may be produced by combining them together in different manners, and take n to represent the number in the formula.

In the first place, by making a sufficient metallic communication between all the copper cells, and another between all the zinc rods, we make an arrangement equivalent to multiplying the area of the section of the electrolyte by the number, as by proportionately increasing the size of the plates, and we decrease the internal resistance in the same proportion, thus our formula becomes,

$$\frac{E}{\frac{R}{n}}=\frac{nE}{R}=A^*$$

The exterior resistance, r, of the connecting wires being still taken as inappreciable, the quantity of force which would circulate through a sufficient conductor would be n times as great as that in a single cell, and might be measured either by its heating or its magnetic effects; and n times as much zinc would be consumed, or work performed in the cells.

Such an arrangement, however, confers no increased power of overcoming exterior resistances, and any obstacle which would be capable of arresting the current in a single cell, would arrest it in any number so combined.

2nd. To effect this purpose the efficient force of one cell must be added to that of another in a series, and the sum of all brought to bear upon the resistance. Ohm's formula then becomes

$$\frac{nE}{nR+r}=A$$

in which n represents the number of the series. In this arrangement we observe, that if r again be taken as nothing,

$$\frac{nE}{nR}=\frac{E}{R}$$

and we in fact found in our experiments, that when no retarding cell was introduced into the series, the work done in each cell was no more in series than when working as a single circuit.

Now, so long as the external resistance r interposed in the circuit is not chemical, whether it be the resistance of very long wires or of non-conducting air, the formula as above given accords strictly with the results of experiment; and by doubling the number of cells, at the same time that we double the efficient surface (or the area of the section) in each cell, we obtain an effect exactly double: thus by the formula—

$$2\left(\frac{nE}{nR+r}\right)=\frac{2nE}{\frac{2nR}{2}+r}=\frac{2nE.}{nR+r}$$

since in doubling the surface, *cæteris paribus*, we halve the resistance.

3rd. When, however, a voltameter or other chemical resistance is interposed in a circuit, the formula will not hold, unless an opposite force of affinity be taken into consideration, which arises from the decomposition of the active liquid, and consequent accumulation of the disengaged elements upon the plates of the decomposing cell.† This is of the same nature as the contrary force in the cell itself, which has been already pointed out and designated by e' in the formula $E=(-b-e')$. Assuming this contrary affinity to be constant, it may be represented by e, and introduced into the formula thus;—

$$\frac{E-e}{R+r}=A$$

and tables might be calculated from it which would represent approximatively, the quantity of decomposition for any number of

* It must be borne in mind that it is only when the external resistance, r, is so small, in comparison with R, *as to be negligible* that $\frac{E}{R}$ is equivalent to $\frac{nE}{R}$; or, in other words, it is only under this condition that a cell, with plates, say of 3½ in. × 2½ in., placed 1 inch apart, can give a current equal to that from a battery of 20 or more similar cells united in series. When $A=\frac{E}{R}$, it is clear that by using twenty cells instead of one we increase in equal proportion both the terms of the fraction, $\frac{E}{R}$ becoming $\frac{20E}{20R}$, or $\frac{E}{R}$ becoming $\frac{20E}{R}$ and that the value of the fraction thus remains unaltered.

† *Philosophical Transactions* for 1842, p. 269.

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cells of a given battery; while the results obtained by regarding the voltameter merely as a resistance would be widely at variance with truth. Professor Wheatstone devised a very simple means to determine, on this supposition, the values of this contrary affinity, and of the added resistance, including that of the voltameter, without having recourse to any other measuring instrument than the voltameter itself. It consists in comparing two experiments in which the resistances remain the same, while the sum of the efficient forces alone vary. It is obvious that if there existed no contrary force of affinity, the measured effect in the two cases should be simply as the number of the cells in the series employed. A battery of five single cells should have half the power of a battery of ten double cells; but instead of this the effects measured by the voltameter are as 6 : 20; therefore

$$\frac{10\,E-e}{10\,R+r} : \frac{5\,E-e}{5\,R+r} :: 20 : 6\text{; whence } e = 2.157$$

The value of r in the formula, *i.e.*, the resistance which the voltameter and connecting wires add to the circuit may be ascertained in an analogous manner: for taking two similar batteries, one single and the other double, of ten cells each, the sums of the active forces will remain the same, while the interior resistances only will vary. The experimental results of the first were 12.5, and of the second 20, so that

$$\frac{10\,E-e}{10\,R+r} : \frac{10\,E-e}{\frac{10\,R+r}{2}} :: 12.5 : 20$$

whence $r = 8.333\ R$

Substitituting the values thus found in the general formula

$$\frac{n\,E-e}{n\,R+r}$$

we obtain the following comparison of the results of the calculation with those of actual experiment:—

Number of cells	3	4	5	10	15	20
Quantity of gas calculated ...	$\frac{5}{8}$	$3\frac{3}{8}$	6	$12\frac{13}{15}$	$15\frac{11}{12}$	$17\frac{13}{17}$ cubic inches.
Quantity of gas observed.....	$1\frac{1}{8}$	$3\frac{7}{8}$	6	$12\frac{1}{2}$	$15\frac{3}{4}$	$17\frac{1}{4}$ cubic inches.

The existence of such a contrary force of affinity as has here been supposed, and its great energy, are amply attested by connecting the platinum plates of a voltameter which has been some time in action, with a galvanometer, when a deviation will be obtained indicating a strong current in an opposite direction to that of the original current which it had been the means of conducting.

4th. To show the general agreement of the modified formula with the results of various and most trying combinations of the cells which we have taken as our standard of comparison, we will now take the results of a series of experiments which were made for the purpose, and compare them with the results of calculation in a table:

e was found to be by experiment $= 2.49\ E$
r by a mean of several experiments $= 0.541\ R$

If unity be taken to represent the maximum work that *any* single circuit can produce (which we found to be equal to 25 cubic inches of mixed gases per 5 minutes), then E will be represented by 1, and R also by 1, and

$$\frac{E}{R} = 1$$

It is evident that in an effective circuit the resistance can never be equal to the electromotive force, R can never equal E, but for the convenience of calculation it may be assumed to be so; and as all the quantities in the numerator of the fraction are compared with E, and all the denominator with R, the relative proportions will be exact.

Taking then the formula—

$$\frac{n\,E-e}{n\,R+r} = A$$

if E=1 and R=1, then e=2.49 and r=0.541; and substituting different numerical values for r, we obtain

		Calculat. Cub. in.	Experim. Cub. in.
For 4 single cells	$\frac{4-2.49}{4+0.541} = \frac{1.51}{4.541} = 0.3325 =$	8.31	7·5
4 double cells	$\frac{4-2.49}{\frac{4}{2}+0.541} = \frac{1.51}{2.541} = 0.5942 = 14.85$		13·7
4 treble cells	$\frac{4-2.49}{\frac{4}{3}+0.541} = \frac{1.51}{1.871} = 0.8071 = 20.17$		21
4 quadruple cells	$\frac{4-2.49}{\frac{4}{4}+0.541} = \frac{1.51}{1.541} = 0.9799 = 24.5$		25·5
4 quintuple cells	$\frac{4-2.49}{\frac{4}{5}+0.541} = \frac{1.51}{1.541} = 1.126 = 28.15$		30
5 single cells	$\frac{5-2.49}{5+0.541} = \frac{2.51}{5.541} = 0.453 = 11.33$		11·25
5 double cells	$\frac{5-2.49}{\frac{5}{2}+0.541} = \frac{2.51}{3.041} = 0.8254 = 20.63$		20·5
5 treble cells	$\frac{5-2.49}{\frac{5}{3}+0.541} = \frac{2.51}{2.208} = 1.137 = 28.42$		28·7
5 quadruple cells	$\frac{5-2.49}{\frac{5}{4}+0.541} = \frac{2.51}{1.791} = 1.401 = 35.04$		35·2
10 single cells	$\frac{10-2.49}{10+0.541} = \frac{7.51}{10.541} = 0.7124 = 17.81$		15·7
10 double cells	$\frac{10-2.49}{\frac{10}{2}+0.541} = \frac{7.51}{5.541} = 1.355 = 33.88$		33.7
15 single cells	$\frac{15-2.49}{15+0.541} = \frac{12.51}{15.541} = 0.8117 = 20.29$		18·7
20 single cells	$\frac{20-2.49}{20+0.541} = \frac{17.51}{20.541} = 0.8524 = 21.31$		22.

The agreement of the calculated and experimental results under such complicated circumstances, as shown in the last two columns of the preceding table, must be deemed very satisfactory; and it is worthy of remark, that the result of the independent experiment with the single cell, 25 cubic inches is almost identical with that deduced from the experimental determination of five cells; taking 11.25 cubic inches to represent accurately the fraction 0·453; and, indeed, it agrees very closely with the calculated results of the above table, whatever combination be taken as the foundation of the experiment.

The resistances of reversed cells in a series, and in general all possible combinations of active forces, direct and opposite, with various resistances, may be submitted to calculation in the same manner with a precision and simplicity which leaves little to be desired in this branch of our subject, but our limits will not admit of our doing more than thus indicating the method by which the phenomena of circulating affinity have been brought under the powerful dominion of the mathematics.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—When "Relay Magnet" distorted my meaning by representing the word *adequate* as implying in my context a source made by corresponding fluctuations in force, sufficient for all exigencies, he at the same time carried the distortion into my analogy also, by imputing to the water source similar fluctuations. The former he corrected by striking out the word he had abused, but he still leaves uncorrected his fluctuating source of water. This seems disingenious; I must therefore say more than I was willing at first to think necessary. By my phraseology, which ran thus, "Supposing all the parts of a wire to be working at the same time, each receiving electricity from the part next before it, and the first receiving it from

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an adequate source of supply"—the word adequate really expressed what the whole context plainly required; namely, that the source of supply to the first part was "equal to" the source of supply to the second part, the third part, and so on, that is, "equal to" the quantity moving in each of the parts successively. As the hydraulic analogy, in order to be an analogy, must have been under the same equality as to the source of supply, the expression "adequate source," introduced by "Relay Magnet" to imply *variable force*, must have slipped in by some mistake that calls for explanation. He shows that he himself knew that "adequate" means "equal to," and, aware that my profession enforces upon its members at least a rudimentary acquaintance with the language from which the word has been derived, he can hardly have imagined me to be ignorant of its etymology.

He is mistaking, I must suppose, inadvertently, the *conductivity* of my theory for the *signalling power* of the same system, or for "conduction" as generally understood; and he then, of course innocently, asks me to inform him how the consequent absurdities are to be avoided.

According to his own showings, he is unconscious that the confounding of addition with multiplication is no less confusion if the confounder be not a mathematician. "Relay Magnet" makes me know that he is himself a mathematician, and therefore can reason correctly. To me it is exceedingly unpleasant to have to expose sophistry in any of its forms; and I hope I shall have no further occasion to do so—Yours &c.,

RICHARD LAMING.

To the Editor of THE ELECTRICIAN.

In your last Number Mr. S. E. Phillips has referred to a letter of mine in the ELECTRICIAN of February 13th. I am glad he has done so, for, on reading my letter again, I find it may be misunderstood. I said the metals given for the formation of a battery would be "most efficiently employed," when I should have stated that the "maximum effect" or strongest signal *would be produced*—which is quite a different thing to the most advantageous practical arrangement for working a cable.

The law will be found in Gavarret's "Electricité," Vol. II, p. 108, and in the English translation of De La Rive, Vol. II, p. 821. I passed no comment upon it, but simply wished to state it correctly.—Yours truly

R. S. CULLEY.

INSULATING COMPOUNDS.

To the Editor of THE ELECTRICIAN.

SIR,—In 1860 I made numerous experiments upon various materials combined in layers for insulating purposes. The result was communicated to the Electrical Committee of the late Telegraph Commission, and not emanating from themselves, was of course pooh-poohed. I published a few of the results in the first Number of the ELECTRICIAN, and the reinsertion of the note may now do some good, as patents are continually being taken out for new combinations, compounds, &c.

"EXPERIMENTS ON INSULATION FOR STATIC ELECTRICITY.

"1.—Copper wire, covered with india rubber, and then with gutta percha.

"Insulation not nearly as high as when covered with india rubber alone.

"2.—Copper strand, covered with india rubber, then with gutta percha and Godefroy's compound.

"Insulation very low, much lower than if the strand were coated with india rubber alone.

"3.—Gibraltar core, covered with a coating of vulcanized india rubber, then with a thick coating of Chatterton's compound.

"Insulation lower than that of a thin coating, say $\frac{1}{32}$-inch of plain gutta percha.

"4.—Copper wire, covered with virgin rubber, cotton thread between two coatings.

"Insulation very low.

"The outer coating stripped off, and the cotton removed, the insulation was far superior; although the thickness of the coating had been reduced one half and more.

"It therefore appears that a superior insulator, coated over with an inferior one, affords no advantage; and that an inferior insulator, coated over with a superior one, is a positive disadvantage. "A."

Mr. Latimer Clark, in his Report to the Telegraph Committee, makes the following statement:—"A first coating of india rubber surmounted by gutta percha forms an excellent combination." Mr. Clark, under such an impression, had a length of core constructed upon the above principle with the view, I believe, of adopting such a core for the Persian Gulf cable. The result was in accordance with my experiments, an enormous loss of insulation and enhanced retardation, in comparison with a copper wire of the same dimensions, covered with india rubber or gutta percha alone. The table itself would be exceedingly instructive if published in your columns, and would no doubt be the cause of saving much trouble and expense to our inventors generally. OWEN ROWLAND.

THE PERSIAN GULF CABLE.

To the Editor of THE ELECTRICIAN.

SIR,—Your correspondent, "One who pays," has expressed the opinions of all practical electricians and chemists. The proposed cable will prove a worthy successor to the Red Sea, the Algerian, and the precarious Alexandria and Malta cables. I have a portion of the Red Sea core now before me, which has been exposed to light and air for a short time. It resembles common rosin in character more than that of gutta percha. The volatile oil of the tar has completely destroyed the homogeneousness and elasticity of the material. A CHEMIST.

Telegraphic News.

ATLANTIC TELEGRAPH COMPANY.

IT will be seen from our advertising columns that the directors, in convening a general meeting of shareholders for the 19th inst., announce that more than two-thirds of the first issue of preferential shares (to the amount of £300,000) have now been subscribed for.

THE EUROPEAN AND AMERICAN TELEGRAPH.

THE line of telegraph which is one day to unite the two worlds, *viâ* Siberia and Aleutian Islands, now goes as far as Omsk, in Siberia. The charge for a despatch from Paris to that place is 30 fr. Omsk is on the Chinese frontier. Merchants who have correspondents in China, address their despatches to the Russian Embassy at Pekin, which sends them to their destination.

Miscellanea.

THE ELECTRIC LIGHT.—This light was shown in great power and brilliancy at Hull, by Mr. T. W. Stears, Electrician, on the evening of the 10th instant, 80 Maynooth batteries were employed on the occasion. Its effects in the immediate and surrounding neighbourhood was beautiful, and when reflected towards the sky the rays could be seen over the town to a considerable distance.

FOOD: ITS DESTINATION AND USES.—In the "Proceedings of the Royal Society," Mr. W. S. Savory has given an account of his experiments in relation to this subject performed upon rats and a hawk. Their diet was divided into three classes:—1, a non-nitrogenous, consisting of equal parts, by weight, of arrowroot, sago, tapioca, lard, and suet, which yielded only 0·22 per cent. of nitrogen; 2, nitrogenous—viz., lean veal, from which every visible particle of fat had been carefully removed, which yielded only 1·55 per cent. of fat; 3, a mixed diet—the two former combined. The weight, temperature, and general condition of the animals were especially noticed. The following conclusions were drawn:—Nitrogenous materials are not only calorifacient, but, at least under some circumstances, sufficiently so to maintain alone the requisite temperature. It is in the highest degree probable that, under certain circumstances, nitrogenous materials may prove directly calorifacient without forming tissue. Non-nitrogenous substances are, at least under some circumstances, directly calorifacient without entering into the composition of tissue of any kind. While non-nitrogenous food only is taken, all the nitrogen which is excreted in the urine, and more, may be accounted for by the disintegration of the original tissues, without assuming that any fraction is assimilated from any other source. While life cannot be maintained without nitrogenous food, even though every other kind be abundantly supplied, death in this case being due to loss of tissue, life, and even health and the normal temperature can be maintained, at least for a long period, upon diet almost exclusively nitrogenous, with proper inorganic substances in which there exists only a small fraction of non-nitrogenous matter. Such a minute proportion of fat must be but a poor representative of non-nitrogenous food. Lastly, in these experiments the significant fact appeared, that while the weight, strength, and general condition of the animals varied very widely under different diets to which they were subjected, no considerable fluctuation was observed in their temperature. Even the slight variation from time to time recorded seemed rather to result from other causes than depend directly on the food.

To Correspondents.

STUDENT.—Fahrenheit's boiling point is 212°, Reaumur 80°, and the Centigrade 100°. In reducing the degrees of Fah. scale above 32° to those of the Centigrade, the number of degrees above or below 32° must be multiplied by 5 and divided by 9; and to reduce those of Fah. to Reaumur, the number of degrees above or below 32° must be multiplied by 4 and divided by 9.

T. ENGINEER.—Tar is *gradually* decomposed by electricity of low tension, and rapidly by electricity of high tension. The insulating quality of shellac is lowered in course of time by electric action.

ENQUIRER.—The velocity of projectiles is now frequently ascertained by the aid of electricity. Several interesting experiments have been made at Woolwich, Shoeburyness, &c., to that effect; and insulated wires of considerable length have lately been supplied for the purpose.

OMICRON.—Too late for the present number.

H. C. FORDE.—Too late for this week.

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The Electrician.

Vol. III. No. 72.—March 20, 1863.

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MR. LAMING'S THEORY OF CONDUCTION.

We are glad to perceive that, in regard to his statement to the effect that "a large conductor with small ends can act no better than another conductor small throughout its entire length," Mr. Laming has accepted the only alternative at once practicable and satisfactory to himself, and has signified that, in this instance at least, his premises do not imply the above contradiction to a well ascertained fact and to carefully verified theory. Although we would fain point out the difficulty and danger of traversing by a few inductive inferences, instead of by very many experimental and inductive steps, the space which separates the phenomena of the voltaic circuit from those of static electricity; we may state our conviction that it is by almost unavoidable oversight, rather than through logical inaccuracy or a defective foundation, that conclusions at variance with fact have thus been derived from certain fundamental principles of electrical action established by Mr. Laming. We pray therefore the "wiser ones" in the science of applied voltaism that they will not lightly question or deride our principle of allowing such propositions as the above to receive some discussion in our columns. We write mainly for those who most require teaching, but with the hope that we may sometimes, —as is quite possible in the present case, elucidate instruction for all who are interested in the progress of the science, ourselves certainly not excepted. It must be remembered that the number of those who have any well defined and sufficiently extended views upon the nature of electrical effects, and the theory of the dynamic circuit, is comparatively small,—smaller, we imagine, than some might anticipate. Our object is to extend and popularise electrical science, as well as electrical applications; and, to many who have not already carefully verified the laws of the voltaic circuit, the present may be a favourable opportunity for taking up the subject with a certain degree of interest and zest that discussion, when properly conducted, seldom fails to inspire.

Nevertheless, Mr. Laming, as well as others, will, we think, see the necessity for confining the present discussion within certain limits that we have traced for ourselves. For the present we must deal with conclusions, not principles. The readiest, and not the most inaccurate, method of judging of things is by their fruits—albeit the fruit may possibly not be always a fair criterion of the producing power. Mr. Laming however obtains his own conclusions from his own principles; and to him we must leave the somewhat serious task of the revision of both, or of either, should such revision be found necessary, as we doubt not will be the case. Thus, if Mr. Laming's theory be ultimately perfected, and, by assimilation to that of Ohm, or otherwise, be made to include all the phenomena of dynamic electricity, it will be at a much less expenditure of argument, and of our space, than would follow from the present consideration on our part of the means by which his results have hitherto been obtained.

The actual culminating point of Mr. Laming's chain of inductive inferences is a formula somewhat similar to, and intended, as we apprehend, to replace, that of Ohm, giving the active and opposing forces in the circuit. Mr. Laming's formula is as follows:—

$$P = \frac{S \times T}{L^2}$$

in which P is defined as the signalling power, S the sectional area *of the external portion of the circuit only*, T the motive tension and L the length of wire.

P is clearly equivalent to I in Ohm's formula, viz: the intensity of the current, or the quantity of electricity traversing the circuit. T is identical with E, the electro-motive force of Ohm.

Thus, adopting for the sake of convenience the letters usually employed, the formula stands as follows:—

$$I = \frac{E \times S}{l^2},$$

and this expression, even when one most glaring inaccuracy has been corrected, is defective, as we propose to show, insomuch as it essentially differs from that of Ohm, *i.e.*, in the fact of the fluid resistances of the circuit being altogether neglected.

The most obvious indication of the formula is that by doubling or tripling the length of the wire portion of the circuit, the value of I will be reduced from unity to one-fourth or to one-ninth. It is difficult to conceive that Mr. Laming would seriously advance this as a fact. By simply doubling the external resistance, we can never reduce the intensity of the current to one-half, in certain cases it may be affected but to a very small, or, indeed, to an unappreciable extent. This however, as Ohm's formula clearly shows, by no means negatives the fact that "the resistances of metallic conductors to the passage of the current are inversely as the areas of the sections of the conductors, and directly as their lengths." With Mr. Laming's permission, therefore, we will amend the formula thus:

$$I = \frac{E \times S}{l}$$

Let us assume that this holds good, as should be the case, in a circuit composed of a single cell of Daniell, having its poles united by a few yards of stout copper wire.

Exp. 1. Having determined the value of I, either by means of the galvanometer, the electro-magnet, the heating effect of the current, or the electrolytic decomposition of water or a saline solution; multiply the value of E by 100,—by employing this number of cells united for tension, instead of the single couple. Again determine the value of I. No perceptible increase in the current will be found.

Exp. 2. The above result is sufficient to disprove the accuracy of the formula; since E and S are connected by the sign of multiplication. Let us, however, now multiply S by 10. The quantity of electricity passing will be augmented but to a very slight, or to no appreciable, extent.

Exp. 3. Again, let us reduce l to one-half. No appreciable increase in the current will be observed.

Exp. 4. We may now try the converse operation, and multiply by 10 the length of wire uniting the poles of our battery of 100 cells. No perceptible *decrease* in the quantity of electricity passing will be observed.

We have, therefore (expts. 1, 2, and 3,), multiplied by 100 and by 10, respectively, the two quantities in the numerator of the fraction, and we have divided the denominator by 2, *without appreciably increasing the value of* I. The multiplication of the denominator (exp. 4) is equally ineffective in *reducing* this value. The equation, therefore, is clearly defective. Although it indicates that the quantity of electricity traversing a circuit may readily be increased or diminished by varying the ratio of the upper and lower terms of the fraction, it really, as we have seen, affords no possible theoretical means of increasing this quantity in a circuit of small external resistance. In the contrary case of a circuit of very great external resistance, the formula might appear to hold good; but the error, though reduced, would still be perpetuated.

Let us see whether the formula of Ohm will serve us better in explaining the observed phenomena, and in truthfully indi-

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cating the means for increasing the current in the case we have chosen for illustration.

The fluid resistance of a cell of Daniell, similar to those in use upon the lines of the Electric and International Telegraph Company (with porous vessel partially greased to prevent leakage of sulphate solution), has been stated as equal to about 2182 yards of No. 16 pure copper wire. Let us complete the circuit of one of these cells with *three* yards of the same wire, and take the electromotive force of one cell as the unit of tension. Then the value of I, according to Ohm's formula, would be

$$I = \frac{E = 1}{R = 2182 + r = 3} = \frac{1}{2185}.$$

1. Instead of one cell, let us now, as before, employ a battery of 100 similar cells. The equation then becomes

$$I = \frac{100}{218200 + 3} = \frac{100}{218203}$$

since R is increased in the same ratio as E. The value of I, therefore, is scarcely affected; and the formula shows that the augmentation in the quantity of electricity circulating must be inappreciable.

2. Multiply the sectional area of the wire by 10; the value of r is then reduced to ·3. It is clear that this reduction will not cause the current to be perceptibly increased.

3. Reduce the length of wire to one-half: the value of r will be reduced in the same ratio, while that of I will be increased but to a very minute extent.

4. Multiply by 4 the length of wire in circuit. Here we slightly diminish the value of the fraction; but the effect upon I will be practically almost inappreciable.

But the formula plainly indicates that if we wish to augment the intensity of the current we should diminish R. As $R = \frac{S}{D}$, we have only to double the area of the plates in the single cell circuit, or to decrease their distance to one-half; and, instead of the equation in which $I = \frac{1}{2185}$, we have

$$I = \frac{E = 1}{R = 1091 + r = 3} = \frac{1}{1094},$$

the value of I being nearly doubled.

En resumé, we have to recommend Mr. Laming to take into consideration the fluid resistances in a circuit. By operating, in the first instance, with a single cell, he will be able to trace the passage of the current from the generating surface (of the positive element) through the electrolytic conductor to the collecting plate, and thence, through the metallic conductor, again to the positive element. He may then apply his principles to the *circuit*, instead of to a portion of the circuit only; and he will find that, in all cases where the electromotive force is constant, the sum of the two resistances—electrolytic and metallic—gives the exact measure of the intensity of the current.

ON THE LAWS OF ELECTRICITY IN MOTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from p. 216.)

When disputants, qualified for their task, argue with a sincere desire to arrive at the truth, flow it from whichever side it may, the contest has a very different interest for the public than when each simply seeks to defeat the other. In such a case I cannot quite agree with the Editor that it is certain no useful purpose will be answered by endeavouring to obtain a clearer insight into even such doctrines as are at variance with fact; because if we profit not ourselves directly in the attempt, we may be profited indirectly, through the enlightenment of our adversary on some point he may have neglected of an otherwise instructive theory.

I have been, as the readers of the Electrician know, in the habit of expressing confidence in the resources of my theory, and of representing it as true doctrine that cannot, though its advocate may, suffer from fair criticism. It now devolves upon me to give a practical illustration of what I have said in its favour. At page 168, I announced as a result from certain specified premises:—"Hence a large conductor with small ends can act no better than another conductor small throughout its entire length;" an assertion to which the Editor demurred, and upon which we joined issue in discussion, he appealing to professional experience to prove his case, while I turned to revise my Definitions published at the 204th page of this volume. All those Definitions I fairly examined anew, it being to my taste, as well as engagement to the Editor, to seek for a profitable conviction rather than a barren conquest. I could find in them nothing but what flowed necessarily from my theory; while, on the other hand, the assertion protested against, and which was their inevitable consequence, was shown to be inconsistent with fact. One of two things had, therefore, been proved, either that my theory is untrue, or that in some important respect the Definitions I had drawn from it failed to represent it. Before I could entertain the former alternative it was natural I should set about satisfying myself that the Definitions were wanting in no essential feature of the theory, and I had not gone far into that investigation before I discovered an omission, which, being supplied, removed the whole discrepancy between theory and fact, and now indicates the termination of my discussion with the Editor in a manner satisfactory to us both—to him as a zealous public guardian of electrical science, and to myself as one of its promoters.

As soon as I shall point out what that deficiency is, it will be seen that the omission cannot vitiate in the slightest degree any reasoning that either has been, or may be, founded upon the Definitions in their relation to cylindrical conductors; their fault simply is that they do not extend to conductors composed of wires of unequal sectional areas, but they may be made to do so. Although it is not easy for me to account for the omission, it is quite obvious that having made it my Definitions, from which nothing needs to be retracted, could lead me to no other conclusion than that I announced and which gives me not the least uneasiness to recall. I copy the following from my memoir in the Electrician for December 19, 1862, page 74; "When in the *Philosophical Magazine*, for 1838, I had the good fortune first to suggest the definite nature of the electrical attraction, I had occasion to dwell upon the obvious fact, which now will have an important bearing upon our subject, namely, that the power with which common matter retains its equivalent of electricity, is antagonistic to that by which the same electricity may be liberated from it by induction, both powers being due to the same electrical attraction. It would be quite in accordance with practice in the mechanical sciences to speak of the liberating and the retaining powers as *antagonistic forces*." All this I had for the moment unaccountably lost sight of. Now, in the case of a telegraph conductor, the liberating power is the *induction* which establishes conduction, and its amount for the whole line of the conductor is by my definitions the sum total of the *motive tension*; the retaining power, when the conductor is cylindrical, being uniform throughout its length. But when the conductor varies in sectional area, then the retaining powers at its several parts vary inversely as the squares of the several areas. For, consistently with my definition of *intensity*, a current of electricity, passing out of a length of wire into another length of one-half the sectional area of the former, must occasion a double number of particles of electricity to act upon each particle of common matter, liberating from it a double number held with four times the retaining force; and, before the electricity can be liberated, the retaining force has to be overcome by the *motive tension*, which is defined to be constant, however much the sectional areas may change. On the other hand, when a current is passed through the unequal wires with their positions reversed, the particles of electricity, acting upon each particle of the conductor, become reduced in number to one-half so soon as the double area is reached, that reduction sending down to one-fourth part the antagonism opposed to the constant *motive tension*.

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Let the wire of double sectional area be double the length of the smaller wire; there will then be twice the quantity of electricity passing in the larger and longer of the two, because all the sections, whether large or small, are simultaneously passing quantities that are equal, and the numbers of sections are as the lengths, respectively.

In connection with these consequences of my theory one has only to reflect that 1 unit of electricity, acting at one section with 4 units of intensity = 2 units of electricity each acting at 2 sections with 1 unit of intensity, and he will at once understand all that before was wanting.

I have now shown, in compliance with the reasonable requirement of the Editor, that my theory does not imply a contradiction either to the fact he has adduced, or to Ohm, so far as that fact is involved in his formula. But what I have admitted neither negatives my assertion, that the theory of Ohm needs must have breaking-down places, simply because it is invention and not discovery, nor does it remove my objection to that theory as an artificial misrepresentation of physical agency, combining under one term, "resistance" to electromotion, the heterogeneous elements—absence of conductivity, presence of inertia, and antagonism by the normal retaining attraction; no two of which, in the case of any conductor of mixed diameters, admit of being ranged under the same law of variation. Neither have I acknowledged that small ends can be put to telegraph conductors with impunity; which, however, is not asserted to be a fact, notwithstanding the universality of the practice, which, it seems, has been adopted purely for mechanical convenience.

It now remains for me to request of the Editor a continuance of his criticism. I have put before him a number of *Definitions* of the leading matters concerned in electro-telegraphy, which profess to lay open much of the *modus operandi* of nature while they enable it to be calculated with mathematical precision, a combination of qualities that has never before been even attempted by electricians. Alluding to these Definitions, he has said,—"It is quite unnecessary that they should be more fully commented upon. We are ready to admit that in some points they are not only plausible upon abstract grounds, but might possibly admit of such modification as would bring them into accordance with known results." Now that some modification has been pointed out, I want him to be good enough, when he can find the necessary leisure, to take them singly as they will stand, and indicate wherein either of them is deficient of any plausibility, that perfect accordance with universal natural principles should give it, or in the smallest degree dissonant with fact. If he succeed in doing one or other of these things, he will enlighten the Author of the Definitions, and if he fail in both of them, truth will only then be made to shine out the brighter for the benefit of those he is leading onward.

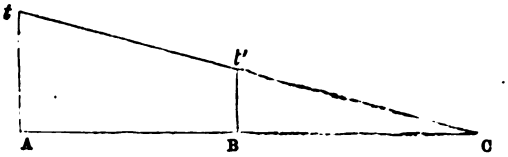
I have no leisure this week to write out the Definitions so as to make them embrace the heterogeneous wires, but the extended list shall be submitted at the earliest opportunity.

THE PROPAGATION OF ELECTRICITY IN LONG CONDUCTORS.

BY CAPTAIN SCHAW, R.E.

Before proceeding to describe the various conductors in use, it will be best to state the laws of the propagation of currents in long conductors. *Currents* of electricity are solely due to differences of tension. In a voltaic battery the negative and positive poles have opposite tensions, which diminish regularly to the central point of the battery, where they neutralize one another, and as long as the poles are not connected, this difference of tension remains as a static force. If the central point be connected with the earth, no alteration takes place; but if one pole be connected with the earth, its tension becomes 0, and that of the other is doubled, the tensions increasing regularly from one pole to the other. If the poles are connected by a short thick wire, the whole quantity of electricity generated is circulated through the wire, a constant current taking place, and all apparent tension ceasing. If the wire be very long, a current of small quantity is circulated, and the tensions are slightly reduced, and distributed throughout the length of the wire in precisely the same manner as in the battery.

The case is similar in a telegraph wire. If A and C represent two telegraph stations connected by an uniform conductor, A C, and if the



current starting from A has a tension = A t; at B, half-way to C, the tension will be B t' (half A t), and at C it will be 0, the diminution of the tensions being accurately represented by the line t C. This will be evident from the following considerations. The quantity of electricity in circulation is equal throughout the circuit, as shown by the equal deflections of a galvanometer when inserted at any point. If the wire be divided at B, and it be required to circulate the same force through B C as was before circulated through A C, we have in one case *$Q=\frac{n\,T}{n\,L+w}$, in the other, $Q=\frac{\frac{1}{2}n\,T}{\frac{1}{2}n\,L+\frac{1}{2}w}$, only the half tension being required to circulate the same quantity through half the resistance. Mr. Latimer Clark has proved the truth of this law by actual experiment on long telegraph lines. (*Vide* his Report in the Parliamentary Report on Submarine Cables.)

The electrical resistances of conducting wires vary as $\frac{l\,s}{d^2}$, l being the length, s the specific resistance of the metal, d the diameter of the section of the wire. When a conducting wire is coated with an insulating material, a second resistance is opposed to the passage of the current, due to induction. The wire becomes charged with electricity in the same manner as a Leyden jar, the wire acting as the inner metallic coating, the insulating envelope as the glass, the water or moist earth, or outer protecting sheathing, as the outer metallic coating of the jar; and, although the electrical tension be comparatively low, the amount of surface is so large in a long cable that the flow of electricity through the conductor is retarded in a very material degree. The same effect is produced in long wires suspended in the air, but in so much a smaller degree as not to be generally noticed. Fuller details on this subject will be found in an extract from the Report of the Submarine Telegraph Committee, but the laws experimentally established by their investigations are as follow:—

1. The inductive charges of insulated cables, when the same insulating material is used, vary, as $\frac{l\sqrt{d}}{\sqrt{t}}$, where l = length of cable, d = diameter of conductor, t = thickness of insulating envelope.

2. The inductive capacities of different insulating materials differ considerably; for instance, a greater inductive electric charge is produced under similar circumstances in a cable insulated with gutta percha than in a cable insulated with india rudder.

3. The distribution of the inductive charge in a cable is not equable: the amount of induction at every point in the conductor varies directly as the tension at that point.

4. The velocity of the current is not increased by increased battery power, because, as the tension increases so does the induction, and consequent retardation of signals.

5. The time required to charge with electricity, or to discharge, an insulated wire, and upon which depends the rate of signalling, appears to vary as the square of the length, but this point is not well ascertained. The great difficulty to practical telegraphy in long submarine cables arises from the fact that the time occupied in the discharge from the far end of the cable is much longer than that required for charging it by the battery, so that a signal which is short and distinct at the near end of the cable will ooze out gradually from the far

* Q represents the quantity of electricity in circulation; T the electromotive force or tension of one cell; n T the number of alternations in the battery; L the internal resistance of each cell; n L the number of such resistances in the battery; and w, the resistance of the external (wire) portion of the circuit.

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end. The time occupied in travelling through 1,500 miles of insulated underground wire was found by Professor Faraday to be about two seconds. About the same interval was observed in the tests of the Atlantic cable, 2,500 miles long; but the rate of signalling through the cable was not more than from 1·1 to 2·5 words per minute (each word having five letters on an average).—*From "The Hand-Book of Military Sciences."*

THE VOLTAIC COUPLE.

Transfer of Elements.—Current and Opposing Affinities.

We have now to consider how the impulse which is derived from the positive element is transmitted through the liquid to the negative element; and how we may account for the extraordinary fact that the radicle of a portion of acid combines with the former, while the equivalent hydrogen, with which it was associated, is evolved upon the distant surface of the latter.

No visible transfer of the disunited elements takes place, and if the vessel which contains the acid be divided by a draphragm of bladder, or a partition of porous earthenware, or other substance capable of imbibing the liquid, and the two plates be placed on its opposite sides, no impediment arises to this extraordinary separation.

The force must be conceived to travel in this part of its circuit by a species of convection, of which a mechanical illustration again may assist us in forming a first notion. When a number of ivory balls are freely suspended in a row so as just to touch one another, if an impulse be given to one of the extreme ones by striking it with a hard substance, the force will be communicated from ball to ball without disturbing them, till it reaches the most distant, which will fly off under its full influence. Such analogies are but remote, and must not be strained too far; but thus we may conceive that the force of affinity receives an impulse in a certain direction, which enables the hydrogen of the first particle of aqueo-acid which undergoes decomposition to combine momentarily with the radicle of the next particle in succession; the hydrogen of this again with the radicle of the next; and so on, till the last particle of hydrogen communicates the impulse to the platinum, and escapes in its own elastic form.

The force thus taken up the conducing plate is transmitted along the connecting wire, with the phenomena which we have described, back to the zinc, and thus the circuit is completed.

The imperfection of verbal communication obliges us to describe these phenomena as successive, whereas they are sensibly contemporaneous. The generated force is commonly described as a current, as of some imponderable fluid, flowing from the zinc through the liquid to the platinum, and back again through the wire to the zinc. The current may as easily be conceived to be made up of a succession of impulses communicated to a distance through appropriate conductors, as of the perpetual generation of a fluid; so, on the other hand, the vibrations of an elastic body might be deemed a current of mechanical force, and all the phenomena of sound explained upon the hypothesis of an acoustic fluid.

The expression, however, of a current is very convenient, and when thus guarded cannot well lead to misapprehension.

It is obvious that a second zinc plate cannot perform the functions of a conducting plate to the first, because it will itself tend to generate a current of exactly equal power in the opposite direction, and the powers at the two places of action being in direct communication will be balanced against each other through the medium of the metals, in a manner analogous to that in which mechanical forces are balanced against each other by the intervention of the lever. But any metal which has a stronger affinity for the radicle of the acid than platinum, provided it be less than that of zinc, may be substituted for it. Thus, copper when opposed to platinum is capable of generating a feeble current; but when opposed to zinc will become an efficient conducting plate. Its attraction, however, for the radicle, though counteracted will act as an antagonist force and check the current; and another kind of resistance to the passage of the current is introduced to our notice by this tendency to a counter current.

As *current affinity* is thus liable to be checked in its course by the tendency of an opposing affinity, so may it be assisted by the more speedy removal from its circuit of the disengaged hydrogen which, by its adhesion to the conducting plate, tends also to generate a counter current. This may be effected by the addition to the liquid of a portion of nitric acid; and in this case no hydrogen will be given off, and the energy of the current, as manifested by its heating and magnetic powers, will be greatly increased. After allowing such a charge to neutralize itself, by its action upon the zinc, and evaporating the solution of the salts which are formed, the addition of lime will disengage abundant fumes of ammonia; thus, proving that, not only has a portion of the hydrogen combined with the oxygen of the acid to form water, but that another portion has combined also with the nitrogen to constitute the volatile alkali.

The hydrogen may also be removed by the action of metallic salts; for, when under the restraint of adhesion, it is capable of reducing the metals from their saline solutions. The formation of the hydrogen, or any other substance capable of generating an opposing current, may even be prevented by the precipitation of the same metal as that of which the conducting plate is formed from one of its saline compounds. A little additional arrangement is, however, necessary to effect this with precision. If a solution of sulphate of copper be merely added to the liquid in the cell which contains the two plates, after the circuit has been completed, the platinum plate will speedily become coated with reduced copper; but a portion of the metal will also be precipitated upon the zinc plate, owing to the hydrogen which still adheres to its surface from the local action: the consequence will be that strong local action will take place upon the surface of the zinc plate, owing to small circuits formed with the copper which attaches itself to it.

If the cell, however, be divided into two equal parts by a diaphragm of bladder, or porous earthenware, and the sulphate of copper be added only to that division which contains the conducting plate, the current will proceed with increased energy, and the hydrogen will be completely absorbed.

The removal of the hydrogen from the circuit may also be expedited by what may be called *mechanical* means as contradistinguished from *chemical*. It may be observed, that the hydrogen which possesses a strong power of adhesion to platinum passes off from the corners and edges of a plate with much greater facility than from its plane surfaces: the adhesion being of course reduced in proportion to the reduction of the surface of contact: and we have already mentioned the greater facility with which vapour passes off from a rough surface than from a smooth one. If the surface of the platinum plate be roughened, or if platinum be thrown down upon a plate of silver in a pulverulent, but still adherent, state, the evolution of the hydrogen is greatly facilitated, and its counter-action diminished.

Notwithstanding the extraordinary modification which the force of affinity undergoes in these combinations, everything is limited by the laws of definite and equivalent proportions. For every 32 grains of zinc expended in the generation of the force, 80 grains of sulphate of zinc are formed, and 1 grain of hydrogen is evolved; or else 80 grains of sulphate of copper are decomposed, and 32 parts of metallic copper are precipitated.

Moreover, if we compare these effects of chemical force with the effects produced by the associated forces, we shall find that, if a certain amount of these compositions and decompositions take place in a given interval of time, a corresponding effect will be instantaneously produced, either upon the magnetic or calorific galvanometer; and if the chemical effects be augmented, the heating and magnetic effects will be proportionately increased. As in the thermometer we adopt the measure of one of the effects of heat, viz., expansion, as the measure of the cause, so we measure the force of the current, either by its chemical, its magnetic or its heating effects.

The local circuits which we have just pointed out as formed by the precipitation of the copper upon the zinc plate, when not protected by a diaphragm, will now explain the action of zinc in its ordinary state, upon dilute sulphuric acid. Perfectly pure zinc acts exactly the same as the amalgamated metal, its surface becomes covered with bubbles of hydrogen, which adhere to it, and put an end to the process of decomposition; but particles of iron, copper, and other metals which are met with in the zinc of commerce, constitute so many points to which the hydrogen is directed by the influence of small local circuits, and the action proceeds. This local expenditure of force does not interfere with that which passes in the principal circuit, and common zinc may be employed for the construction of such circuits, although the metal which is expended in the local action is wasted for the main purposes of the combination.

The affinities of other substances may be thrown into circulation, and when solutions of hydriodic, or hydrochloric acid, are substituted for water acidulated with sulphuric acid, iodides or chlorides of zinc are formed, and their hydrogen is directed to the conducting plate. The conditions of this efficiency we shall advert to more particularly hereafter.

The most energetic affinity unaccompanied by decomposition cannot, however, be thrown into circulation: it is essential that the liquid portion of the circuit should be a compound. The simple and direct combination of zinc with oxygen, or of zinc with the radicle of

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the acid, cannot be made to produce any of the effects of a current, and the decomposition of the hydro-acid, no less than the composition of the salt of zinc, is necessary to this result.

The affinity of zinc for chlorine is so great, that the metal will spontaneously ignite when introduced into the gas, but zinc and platinum have been properly disposed together in liquid chlorine without producing the slightest current. It does not excite a current through the two plates by combining with the zinc, for its particles cannot transfer the force which is active at the point of combination, across to the platinum. It is not a conductor of itself, like the metals; nor is it capable of transmitting the force by that species of convection which we have just described; and, hence, there is simple chemical action at the spot, and no current.

The metals themselves, though excellent conductors, cannot alone be made to transfer the force from the point of generation to a distance. Melted lead and tin are capable of combining with platinum with great energy and the evolution of light and heat; but if a bent tube be filled with melted tin, and one extremity be put into metallic communication with one wire of a delicate galvanometer, and a similar communication be made between the other and a plate of platinum, which is afterwards immersed in the tin, the needle will be affected in a slight degree at the first application of the heat, from a cause which will be hereafter pointed out, but will be no further disturbed when the energetic action between the two metals comes on.—*From Daniell's "Introduction to Chemical Philosophy."*

PROCESS FOR OBTAINING FINELY-POWDERED METALLIC COPPER.

BY M. HUGO SCHIFF.

To obtain finely-powdered metallic copper, mix a certain quantity of a saturated solution of sulphate of copper with some of the same salt in coarse powder, and some granular metallic zinc, and shake the mixture continuously and briskly; the cupric solution is decomposed by the zinc, which is changed into sulphate, and leaves the copper only in the form of a finely divided powder.

As a certain quantity of the excess of sulphate of copper is constantly dissolving, the decomposing action of the zinc continues while cupric salt is in solution.

By this means large quantities of powdered metallic copper can be prepared in a very short time. When a certain quantity is formed, it is thrown on a filter and washed several times with distilled water freed from air, and then with alcohol; it is afterwards dried by pressure, guarded from air and heat, as the metal, when so finely divided, is very apt to oxidise.

During the reaction heat is developed, and singularly accelerates the decomposition of the cupric salt, and after a few minutes the temperature becomes so intense as to render it impossible to hold the flask in the hand.—*Journal d'Anvers.*

SUBMARINE TELEGRAPHY AND THE RETARDATION OF SIGNALS.

As the rapidity with which signals can be transmitted through long lines of subaqueous telegraph cables, is of so much importance in a commercial point of view, we have taken the trouble of collecting together the information afforded upon the subject in the Parliamentary Blue Book, containing the result of the labours of the Board of Trade Submarine Telegraph Committee. Our readers will be amused with the diversity of opinions and contradictions contained in the volume upon a subject of so much importance to the success of the science of submarine telegraphy. It is surprising that, with all the opportunities afforded by the Atlantic, the Red Sea, and the Malta and Alexandria cables to determine the law of transmission, no definite conclusions have been arrived at. It is to be feared that the "notoriety" of being able to detect the exact locality of a fault in an ill designed and defective submerged cable, has been more coveted by electricians than the "fame" of having contrived and submerged a cable endowed with a remunerative speaking capacity and permanency.

We have in some instances *underlined* the original text, and added a few words of comment.

Mr. Saward, in his evidence, states: "The fourth proposal for a submarine cable from Falmouth to Halifax, I must leave mainly to the electricians, as the cable required for such a route would be, I suppose, between 3,000 and 4,000 miles, and I fancy, *if their law of squares* is to hold good, they will consider a line of little more than 2,000 miles a good deal preferable."

Commander J. Dayman, in reply to Mr. Varley's question: "You are aware that, electrically speaking, it would be *very much easier* to work through a cable 700 miles in length than it would be through one of 2,000?" "Yes."

Not simply *very much*, but *enormously* so, we imagine, if the law of square is to hold good.

Col. Tal P. Shaffner, evidently impressed with the correctness *of the law of squares*, states: "Long subaqueous circuits I have not believed for some years past, and do not believe now, to be possible for commercial purposes."

At the foot of the page containing the colonel's evidence, the following note is appended. "Information has been received as to the working of the 750 miles referred to, the maximum speed is seven words per minute." But the dimensions of neither the copper nor the insulator are given.

Col. Shaffner further states: "According to a written opinion given me some time since by Mr. C. T. Bright (now Sir Charles), the retardation of the electric current transmitted through a subterranean line of copper wire, No. 16, was at the rate of one-third of a second for 500 miles, and one second for 1,000 miles; and according to that progression it would be about nine seconds for 2,000 miles if that length of circuit can be brought to commercial telegraphy." He also observes that 99 words had been transmitted through the Atlantic cable in 67 minutes, being a little less than 1½ words per minute, the length of the line being given as 2,058 miles. This would give a transmitting capacity by the law of squares of about thirteen words per minute, through 683 miles, but only eight words per minute per 500 miles, according to Messrs. Siemens' statement.

Mr. Fleeming Jenkin, after describing, in a somewhat confused manner, his experiments to ascertain the amount of retardation to the transmission of signals through long submarine cables, remarks with respect to the action of a relay, "I think there is a limit, and that to set a relay in action the variation in the strength of a current must be, say two or three per cent., of the maximum strength of the current when allowed to flow continuously through the cable, I am certain that that limit is in various lengths of cables as the *square of the lengths* of those cables. The amplitudes, I find, when they are reduced to the same strength of maximum current are in different lengths. *The law of squares, which has been for such a long time propounded by Professor Thomson, is completely verified.*"

Mr. Jenkin does not certainly prove its correctness.

In answer to a question from Professor Wheatstone, as to the *law of induction or retardation* in submarine cables, Mr. Jenkin agreed with the professor that it was not "as the *square*, but simply as the *length*."

Mr. W. H. Preece stated that he had devoted some attention to the question of the retardation of currents of electricity in submarine wires, and gives the following account of tests made by him in 1854:—"I had a series of ordinary galvanometers, a series of relays, and a Bain's chemical marking instrument; the length of circuit was 1,100 miles. Upon using the relays, we found that in a distance of 1,100 miles, before any signal could be registered at the distant end, three seconds elapsed, but with a *simple galvanometer* it required only eight-tenths of a second. It was very curious that with one instrument I could not get the first appearance of the current until three seconds after I had made the contact, while with the other instrument the effect was obtained in eight-tenths of a second." There was a vast difference between the two.

"At what distance was the other end of the wire?—They were both in the same room. There were six underground wires, extending to Manchester, in pipes underneath the railway; and in their effect, and everything else, they may be taken as equal to 1,100 miles of direct line, because we tried very careful experiments to see whether there was any contiguous effect; that is, whether one wire had any effect upon the other, and we could not trace anything at all. They were separate gutta-percha covered wires.

"Neither end went to earth actually?—Neither end went to earth; both ends came into the same office. We sent the current at one end, which went backwards and forwards, and came out at the other, and thus we were able to observe the effects.

"To what do you attribute the difference of speed?—It arose thus: the current, on its appearance at the distant end of the wire, assumes the formation of a wave; the first appearance of the current cannot be noted; in fact, I am of opinion that the arrival of the current at the distant end is instantaneous.

"Then it depends upon the delicacy of the instrument whether you can register it or not?—Yes. It first arrives instantaneously. It comes as a wave, gradually swelling up to its apex, and when the contact ceases it subsides again as a wave. If you represent this wave by a curve, you can get a fair indication of the nature of the current

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Supposing you have a very delicate instrument, perhaps at a distance of 2,000 miles, you get your first indication at half a second. If you adjust the instrument a little stronger, you get the same appearance after a lapse of a second, and so on till you get up to three or four seconds. So that all the experiments made upon the retardation of currents, particularly those experiments made by Mr. Whitehouse, and some others, are of very little avail in arriving at any conclusion upon the speed of currents through submarine cables, because we do not know what adjustment of instrument was used.

"Mr. Saward: To attain that speed you would concentrate your attention upon the delicacy of the relay?—Yes, to the delicacy of the relay, certainly. I consider that the greatest speed in working a submarine wire of a given length will first of all depend upon the size of the conductor, presuming the thickness of the insulating medium to remain about the same as now usually adopted for commercial and economical reasons. In the next place it will depend upon the nature of the current that is used, because there is a given ratio of quantity and intensity in the current, at which you can get the greatest speed through the cable; for instance, with heavy battery power you perhaps will get one signal through in one second, but if you use electro-magnetic power you may increase that speed perhaps to three or four signals a second. With a very large conductor, with proper power, and with very delicate instruments, you will get the maximum rate of signalling through a cable."

Mr. Preece gives not a single instance in which he has proved the capacity of transmission to be as the *square of the length*.

Mr. C. W. Siemens, in answer to a question as to the number of words he was able to send through the Red Sea cable, stated that the section between Aden and Suez was worked at the rate of eight words per minute, and further adds, "I think, with time and little more practical manipulation of the instruments, and a little more care, we shall be able to work ten or twelve words a minute; ten words a minute for 500 miles was the amount that was expected when the contract was let, and it was to that amount that the cable was desirable; we find that the cable will work ten words a minute through 750 miles at one stretch; and thus my anticipations have been fully carried out."

In a table at page 441 of Minutes of Evidence, the working capacity of a length of the Red Sea cable is given as follows—which certainly does not coincide with the above statement:—Length of wire 730 knots; weight of copper per knot 180 lbs.; of insulator 212 lbs. per knot; rate of transmission 6·5 words per minute. Reduced to 500 miles' circuit, fourteen words per minute.

Mr. Saward addressed the following question to Mr. Siemens:—"Have you formed any opinion as to the ratio in which the retardation of the current increases with the increased length of the conductor, whether it increases *as the square*, or in what ratio?" A. This question is one of considerable intricacy, There are certain laws regulating the flow of electricity in the conductors; there is one law on the subject known by the name of Ohm's law, there is another law regulating the induction or the charge of the insulating covering which regulates the resistance of conductors. Now the retardation is the product of those two laws operating one against the other. If the cable is merely extended in length without increasing either the conductor or the insulating covering, the power of speaking through this cable will decrease very much *in the square ratio of its length*; but it is possible to construct a cable for any reasonable speed of communication through it if scope is given to the proportion of the conductors and the thickness of insulating medium to the length.

With all the numerous opportunities afforded him, Mr. Siemens appears, like most of our electricians, to have neglected the most important question bearing upon the successful application of electricity for transmitting intelligence through long submarine lines.

Mr. C. V. Walker, F.R.S., who made numerous experiments upon the Atlantic cable, appears also to overlook the importance of ascertaining by actual experiment the speed at which signals might be transmitted through a long length of cable, if we may correctly judge from the following questions and answers, and other matter extracted from the said minutes.

"In your experiments on the Atlantic cable, did you try to ascertain at what speed signals could be transmitted through the cable, compared with the transmission of simple waves? I have some records at home of letters and messages that have been sent, but I worked chiefly for waves or currents.

"Waves and Morse's letters?—Yes, when I tried for letters.

"Have you any records as to the relative speeds, and the amount you have to deduct from the speed of a wave, to get the speed of transmission of letters?—None."

Mr. Walker, after making numerous experiments upon the inductive "discharges" of various insulated wires, observes:—"They (the discharges) bear no other relation than that any one is greater or less than any other, but how much greater or less each is to another, is not apparent, *and is not to be determined*."

Mr. Walker places on record the time occupied in transmitting the first message through the Atlantic cable, 2640 miles in length, by means of Professor Thomson's galvanometer. The words, "please send the last news from," occupied 11½ minutes in their transmission, or at the rate of about 37 words for 500 miles, according to the law of squares. Mr. Siemens, in the table above referred to, estimates its transmitting capacity at 8 words per minute for 500 miles.

Mr. Thomas Allan, in answer to the Committee as to the method he would suggest to lessen the retardation, replies:—"Make your conductor large enough. It is all a relative quantity. You must tell me what I am to send through the conductor before I tell you what the conductor should be.

"Assuming a certain amount to be sent through, the same as you would send through the Gibraltar cable?—You require a certain quantity and intensity to make your magnet or relay, whatever it may be. There are a variety of these things; some require more power than others. You therefore require the conductor differently proportioned, according to the circumstances in each case.

"In speaking of these causes, you assume that the same effect is to be produced by each?—Very well; if you are going to work two different relays and have two equal conductors, one will charge when the other will not; because you require to put a greater amount of electricity into motion to work the one relay than you do to work the other; one instrument will work through a conductor when another will not work at all,—then you require more electricity, and in so doing you create resistance, and you charge the conductor,—charge and induction are much the same thing.

"Professor Wheatstone: Have you made any direct experiments on the charging and discharging of wires, and on the effect of induction on wires?—I have not had an opportunity of making those experiments upon long wires that many others have had.

"It is only your opinion that you give, and not the result of experiments?—No; it is not on my opinion only.

"Chairman: Am I to understand you to say that as you increase the size of your conductor you would also have to increase the thickness of the insulating material?—No, I did not say that.

"Assuming that a copper wire of a certain size were covered with an insulating material of a certain thickness, and I wanted to send a certain number of words per minute from here to America, what effect would be produced upon that by adding a certain number of steel wires to a central core, in order to obtain strength?—You would get better conductibility.

"Then you consider that you need not increase the size of the insulating material outside?—I do not see that the insulating material, taking a wire of this sort, may not be calculated to suit the different circumstances.

"You do not admit that the amount of charge is proportionate to the amount of surface of your conductor?—I do not admit that the amount of charge is, but I admit that the inductive surface is greater in the one than in the other,—in the case you mention; but as to charging, that is another question altogether from the surface. If it is a larger conductor, it will require a larger amount of electricity to charge it; but you may not require that amount of electricity to be sent through your conductor, therefore it will not charge it. The object is to make your conductor so that it shall deliver easily what you have to send, and what you will have to send will not cause charge or induction; the thicker insulation is one thing that counteracts induction to a certain extent, supposing it to be there, but it should never be there."

(*To be continued.*)

Cheap Alcohol.—A method of extracting alcohol from coal gas has been discovered at St. Quentin, France, by a young chemist named Cotelle. He announces that he can sell his alcohol at 25 francs the hectoliter, while the most inferior spirits produced from other articles is selling for 75 francs the hectoliter. One equivalent of alcohol contains 4 equivalents of olifiant coal gas and 2 equivalents of water. There is nothing new about the obtaining of alcohol from gas; this has been done before, but it cannot be manufactured so cheaply as from grain. Olifiant gas can be made of alcohol as follows:—Take 1 ounce of strong alcohol and 4 ounces of concentrated sulphuric acid and place them in a glass retort capable of holding 10 ounces, and apply a gentle heat. When the liquor boils, olifiant gas is given off. The sulphuric acid should be added to the alcohol in small quantities, and the retort should be shaken after each addition. The olifiant gas thus obtained for experiment is usually passed through a weak solution of potash to wash it.

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ERRORS, DELAYS, AND COMPLAINTS IN TELEGRAPHY.

We extract the following interesting statement from Sir W. O. S. Brooke's, F.R.S., Annual Report of the Electric Telegraph Department in British India:—

Previous to May, 1859, all private messages on business had to be "repeated" at half price extra. In May "repetition" was made *optional*. The repetition messages are now not one-fifth of the former number.

As repetition has always been considered the best security against errors, it might have been reasonably expected that, on its abolition, the proportion of errors would increase very largely.

In an analysis of 22,657 messages transmitted at repetition price in 1858-59, it was found that 492 messages contained errors, being a proportion of one in 46 messages. The 22,657 messages contained 525,617 words, of which there were 689 erroneous, being a proportion of one error in 762 words.

In 1859-60, I have ascertained that in 105,893 messages sent in Bengal, Bombay, Madras, the East Coast, Ceylon, Scinde, and the North-Western Provinces, 1,605 contained errors, being one message erroneous in every 65. The 105,893 messages contain 2,342,812 words, of which 1,982 are erroneous, being one word erroneous in 1,182.

These results are far better than I expected, and show a great improvement on the work of the previous year. They have been obtained by a most careful scrutiny and comparison of the messages. In every single instance the office in which the mistake occurred, and the signaller by whom it was made, have been ascertained and registered. The registers accompany this report, and may be consulted in the general "complaint office" in Calcutta, by any one who takes an interest in these matters.

The errors are, as usual, chiefly in numbers, "six for sixty," "fifteen for fifty," and the like. Names of places and persons, especially of natives, "purchase" for "purchased," "insure" for "insured," "ship" for "shipped," "about" for "above," "bales" for "sales," 90 per 100 being the confusion of similar sounds in words of different meaning, or the omission of a letter or syllable. The action of atmosphere, electricity causing the instruments to work and give articulate sounds while delivering messages, is a common cause of these errors. But in many cases they arise from haste or inattention on the part of the signallers. That instances of gross stupidity occur from time to time on the part of signallers and assistants is undeniable. It should be remembered, however, that the process of receiving a telegraph message is one in its very nature liable to the misinterpretation of what is seen or heard. Any one who has had to correct the first proof of an article set up by an East Indian or native compositor can understand at once how great is this liability to errors when the same agency is employed to write down from the *dictation* of an instrument, or to decipher its traces and dottings on a paper tape.

The true wonder is that so few mistakes occur. The sufferer by such blunders generally appeals to the press, and cites his case as a specimen of the general working of the department. The conclusion is not just. Nothing is heard or known of the 1,182 words which have been sent correctly, while loud indignation is naturally expressed for the one error in that number.

I am unable to present an exact report on the number and nature of *delays*. My instructions for special returns on this head have not been properly carried out by the Deputy Superintendents. In the rainy season and in thunder storm months, many interruptions occur from natural causes, which cannot be prevented. But many gross instances of criminal neglect in the offices have been brought to my knowledge, and I much doubt if this sad drawback to our efficiency can ever be obviated, till the Chief Superintendent is invested with the power of summary dismissal of the offenders *without appeal to Government*. If his authority be increased to this extent, and if he performs his duty regardless of anonymous libels and vituperation, he may succeed in reforming this evil, which must otherwise be a constant blot on the department.

In every case of undue delay, as well as in those of serious errors or non-delivery, a refund of the sum paid for a message is at once made to a complainant, and the assistants to blame are punished as severely as the state of our establishment permits.

The sums refunded during the year amount to but a small percentage on our receipts, although we encourage complaints in every way, and although incessant attempts are made to defraud the department by false or frivolous claims. For the purpose of affording every facility for the investigation of complaints and the refund of sums fairly claimable, a separate central office was established in Calcutta, in December last, in addition to the local offices. In the central complaint office every "*through*" message sent in India and Ceylon is traced and compared, *whether complained of or not*. No such attempt is made, no such trouble taken in any other part of the world.

A specimen of the weekly return made by the complaint office is annexed in illustration of the pains bestowed on this branch of our business.

Since the opening of the general complaint office to the 30th April, the following refunds have been made:—

For Bengal	Rs.	392	3 0
For Bombay...	„	69	3 0
For Ceylon	„	41	4 0
For Madras	„	4	10 0
For Dacca	„	4	8 0
Punjab, Rohilcund, and Oude ...	„	7	2 0
Total number of complaints ...	„	154	0 0
Total amount refunded	„	518	14 0
Total amount refunded in Bengal Division for the *whole year* ...	„	1,479	8 0
Bombay Division	„	1,255	9 0
Madras Division	„	112	0 0
Total Refunds, Rupees		2,847	1 0

being Rupees 0-10-8 on the total receipts of the year, *viz.*, Rupees 4,23,991-0-0.

ATLANTIC TELEGRAPH COMPANY.

REPORT OF THE DIRECTORS TO THE SIXTH ORDINARY ANNUAL MEETING OF THE SHAREHOLDERS, HELD AT THE LONDON TAVERN, BISHOPSGATE STREET WITHIN, IN THE CITY OF LONDON, THURSDAY, MARCH 19, 1863.

The Directors herewith present to the Shareholders the audited balance sheet, showing the receipts and expenditure of this Company from its commencement, and for the year ending December 31st, 1862.

The enduring interest which the Board continue to feel in this undertaking, and their confidence, after five years' experience and examination, that it can be effectually carried out, have induced them to advance from their private resources during the past year, such sums as have been necessary, in order to keep intact the valuable privileges and concessions of the Company, and to provide other expenses incidental to the efforts now satisfactorily progressing towards obtaining the subscription of a new capital.

The new capital referred to consists of a maximum nominal amount of £600,000, divided into shares of £5 each—£1 per share of which is payable on allotment. It is guaranteed 8 per cent. per annum by the British Government, on the completion and during the working of the cable, and its issue was duly authorized by the Extraordinary General Meeting of the Shareholders, held on the 12th of December last. The terms of issue are further authorized by the Company's Act of Parliament, and are fully set forth in the prospectus, which can be obtained at the office of the Company.

While deeming it prudent, in order to provide for every emergency, to obtain authority for the whole £600,000, guaranteed by Government, the Board believe that this amount will be in excess of the sum actually needed to make and lay a suitable cable.

With that view they have, therefore, determined on commencing the allotment of shares, in conformity with their prospectus, when the subscribed amount reaches £300,000, having reason to believe that this will go far towards providing the necessary cash expenditure for that purpose.

They have used, and are continuing to use, their best exertions to obtain subscriptions, chiefly by private applications to eminent banking, mercantile, and shipping firms in London, Liverpool, and other places; and they would here point out to the Shareholders individually the important aid which they themselves may afford to the directors in this way, by obtaining subscriptions among their own personal friends and connections. It is thought they may do this with great hope of success, and the directors would strongly urge upon them to follow such a course, not merely resting their solicitations upon the basis of the very large remuneration that is certain to arise out of the working of the cable, but also upon the grand and beneficent results, national and commercial, which are sure to follow on its completion.

Meetings have been held in Liverpool, Manchester, and Sheffield, at which the Chairman of this Company has devoted himself to the task of explaining the circumstances attendant upon the scientific

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success of the first great experiment in telegraphing across the Atlantic, the causes of the subsequent failure through imperfect manufacture and management, and the reasons which have convinced the directors that a proper and well-manufactured cable can be readily and permanently laid, by the observance of ordinary watchfulness and care throughout the various stages of its construction and submersion.

The efforts of the Directors and their friends, have up to this time resulted in obtaining subscriptions from persons of the very highest commercial standing and responsibility, for an amount exceeding £200,000

So soon as the subscriptions reach £300,000 the allotment will be made, and a deposit of one pound per share will be called for as already stated. When this is accomplished the Directors feel the fullest confidence that even if an additional amount be eventually required, to make up the cost of manufacturing and submerging a suitable cable, it will be readily provided for.

It is in contemplation to hold meetings for the promotion of subscriptions in the great centres of capital and commerce; and from such and subsequent exertions the Directors hope for satisfactory results.

The Directors have thought it desirable to strengthen their position by inviting the assistance of other gentlemen of influence as members of the Board, and accordingly, acting under the powers vested in them by the shareholders at the Extraordinary Meeting, on the 9th of June, 1859, they have, with the consent of the following gentleman, elected them Members of the Direction, viz.:—

Sir Samuel Cunard, Bart., of the British and North American Steam Packet Company.

Sir William Brown, Bart. (Messrs. Brown, Shipley and Co.), and

Mr. Edward Cropper, (late a Director of the London and North Western Railway Company).

As the Directors' power to elect under the above resolutions, only extends to three members, and as they are prevented by another resolution of the Extraordinary Meeting of June, 1859, from increasing the number of the Board beyond twelve; they propose at the present meeting to rescind the latter resolution, and to substitute in place thereof a resolution extending that number to eighteen, the number allowed by Act of Parliament, after which they will propose for election by the shareholders Mr. George Parker Bidder, C.E., late President of the Institution of Civil Engineers, who has consented to join the Board if elected.

The Directors retiring by rotation at the present meeting are as follows, and they all offer themselves for re-election—

The Right Hon. James Stuart Wortley,

Mr. C. M. Lampson,

Mr. Samuel Gurney, M.P.,

Captain A. T. Hamilton.

The honorary Directors retiring by rotation are as follows, and these gentlemen also offer themselves for re-election.

Mr. A. A. Low, of New York.

The Hon. G. E. Cartier, of Quebec, Lower Canada.

The Hon. John Robertson, St. John, New Brunswick.

Mr. H. W. Blackburn is the only auditor of the Company, and as it is not proposed at present to add a second, his retirement will only be *pro formâ*, and the Directors recommend his re-election.

By order, George Saward, *Secretary*.

2, *Old Broad Street*,
London, 14*th March* 1863.

The Student.

SECONDARY BATTERIES.

(Continued from p. 182.)

The great power of the secondary combinations we have referred to is due to the presence of the peroxide of lead in contact with the negative element in these combinations. This substance, as was pointed out by M. De La Rive, surpasses even nitric acid in its affinity for hydrogen, and for this reason a couple constructed with a negative element of platinum, surrounded by a mixture of dilute sulphuric acid and the peroxide of lead, and with a positive element of amalgamated zinc, in dilute sulphuric acid, is more powerful even than the couple of Grove. And when lead, instead of platinum, is used for the negative element, the power of the couple is but little diminished. Now, by the action of a battery of any kind, providing the tension or electromotive force be sufficient, we may readily obtain a secondary couple, or any number of secondary couples, constituted either upon the principle of Grove's, or according to the plan of De La Rive, of using the peroxide of lead instead of nitric acid. Such secondary couples may be capable of remaining in action only for a few minutes, or for a very much longer space of time, according to the period during which they are *charged* by means of the primary battery. And, as the peroxide of lead is somewhat difficult to obtain by chemical means, and nitric acid is expensive, it may often be convenient to utilize the current from any small battery we may have at hand in the production of more powerful combinations. We will now proceed to describe a few experiments bearing upon the present subject matter.

1. Attach a small strip of lead to the positive (copper) pole of a battery of six or more Daniell's cells (which may be of the very smallest size), and a similar strip of amalgamated zinc to the negative pole. Immerse both these electrodes in dilute sulphuric acid, to which may be added a few crystals of the sulphate of zinc; the zinc will not be attacked by the solution, but, if the salt of zinc be present, will receive a deposit of reduced metal. The surface of the lead will soon be covered with a coat of the brown *peroxide of lead*.

2. Connect the lead and zinc elements of the secondary couple with the terminals of a galvanometer. A powerful current will at first be indicated, but will become gradually weakened until at length no farther effect will be observed than that which is due to the difference of the affinities of the metals in their ordinary conditions, the whole of the peroxide of lead having then been reduced. The couple may now again be charged by the primary battery, with the same effect as before.

3. With the same primary battery, we may excite a dozen or more similar secondary couples. These should be in separate vessels, if tension effects are to be produced, and, in charging, all the lead elements are attached to the positive pole of the battery, the zincs being connected to the negative pole. If, when the secondary battery is charged, the similar elements be united, the arrangement is equivalent to a single cell of larger surface, and may thus be used for "quantity" effects.

4. If, on the other hand, the cells be arranged in series, by connecting the lead of one cell to the zinc of another, very high tension is obtained. With the twelve secondary couples, fully excited by a battery of six Daniell's cells, the tension is equivalent to at least 40 elements of Daniell arranged in series. Thus, with a primary battery of comparatively low power, it is possible to obtain, through the action of a secondary battery, a current of very high intensity, either with a small or a great resistance in circuit.

We will next proceed to describe the means for obtaining a secondary couple on the principle of that of Professor Grove.

(*To be continued.*)

CABLE SUBMERSION.

Next to the proper manufacture and the use of materials which experience as well as experiments proves to be best, there is nothing appertaining to a telegraph cable of more importance than its submersion, for certainly the most perfectly constructed cable may be seriously injured, if not rendered wholly useless, if the paying-out apparatus be of that rude and inefficient description hitherto in use, and which has doubtless contributed not a little to swell the catalogue of failures which disfigure our telegraphic annals.

Up to this time, however, this matter has not received the share of attention which its importance demands; indeed, efficient means of submersion has been the last thing thought of by those who hitherto have been unwisely entrusted with the momentous work of laying submarine cables; and so no more consideration has been accorded the subject than if it were a matter of the easiest accomplishment, or than if, when the cable is once made, it were endowed with sufficient consciousness and power of volition to deposit itself on the bed of the ocean; but now we are beginning to open our eyes to its importance, to have some faint notion that this is an affair upon which it would be as well to let in the light of a little nautical experience, concluding that when a thoroughly good cable has been made, embracing really the "recent improvements in the science of telegraphy," it should be handed over for submersion to experienced seamen. Of course these are notions only held by those in the vanguard—the pioneers of telegraph advancement, or, as the respectable old stagers would dub them, the headlong, reckless and utopian innovators. But even these most respectable superannuated conservatives must perforce give in that there is room for improvement here; this they will probably admit with some reluctance in the abstract, but *de facto* they ignore it; they will have none of your innovations and new fangled phantasmals. And so we have a council appointed consisting of the foremost men in electrical science to deliberate and cogitate, and wrangle perhaps upon the multifarious questions involved in an Atlantic cable of one unbroken length of some 2000 miles, from which the *nautical element is utterly*

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excluded! This is anomalous, to say the least, and decidedly not the way to beget that confidence in the public mind which is absolutely essential should exist in an enterprise of so much importance, attended, as it necessarily will be, by a more than ordinary number of risks. It should surely be the first consideration of a public company to secure the confidence of the public it appeals to, ere they solicit a support of an enterprise of such gigantic proportions as that of an Atlantic cable which admits of no middle course between a glorious success and ruinous failure; and one would think that no body of reasonable men would omit to take into its councils any element, however insignificant, which should contribute in the remotest degree to secure the former and avoid the latter, seeing that the boundary line between the two in affairs of such stupendous importance is not unfrequently very contracted. A word to the wise should be sufficient; it remains to be seen if the Board of the Atlantic Telegraph Company are wise enough to abjure the spirit of exclusiveness which has hitherto characterized its proceedings; public confidence is not to be secured by means of mere promises, however ample, nor by flowery speeches, however unexceptionable the rhetoric; we must have *bonâ fide* action to correspond with and support the same, or the shares yet to be appropriated deserve to remain as they are, and this magnificent enterprise, however desirable its consummation, should be held in abeyance, or the confidence of the public transferred to some other company more worthy of it until they prove themselves worthy of such confidence by a timely compliance with necessary stipulations, which it is as much their interest to conform to as it is the public's to demand.

But this is in part a digression, the object of this paper being some considerations on the mode of submerging cables, by Captain Selwyn, with certain contextual remarks occasioned by his paper, read before the Inventor's Institute, and these I offer with all deference, seeing that I am almost innocent of the smell of salt water; and where I have the temerity to differ from him, I do so with considerable diffidence. One cannot forbear remarking on the outset, that it seems to be a human characteristic to put up with the most miserable makeshifts in matters of importance, and the barbarous inefficiency seems to be in the inverse proportion to the importance of the end to be attained; hence it comes to pass that in the effort to accomplish affairs of great moment the means used are wretchedly ineffective, whereas if it be a trifle we have to accomplish nothing can surpass the exquisite elaborateness of the machinery.

The method of submerging telegraph cables invented by Captain Selwyn is at once so ingenious, simple, and natural as involuntarily to beget a feeling of surprise that so sensible and effective a method did not suggest itself in the first instance. But doubtless it is just the simplicity of the invention that stamps its originality, for, in fact, that which is the most simple is ever the most effective, and that which is in accordance with the requirements of a given case is that which is most difficult to hit upon, and only a favoured few are to be numbered as discoverers thereof. Of course, when a man has made a really serviceable discovery, we are all struck with its extreme simplicity, and are apt to derogate the credit due to the inventor, since which of us might not have done the same thing? And so Columbus, when he discovered a new continent, was considered to have done no great things, as, who among European explorers might not also have stumbled on the shores of the new world? And when envying quibblers would have detracted from his greatness, we know how he dumbfounded his opponents with an egg.

It remains to be seen whether Captain Selwyn's invention will receive that ready and hearty adoption which it merits, for certainly it is as far in advance of existing methods of submersion as a cable itself, in whose construction every improvement has been taken advantage of, is superior to the first rude effort that was made.

Doubtless it will be ultimately adopted, when lapse of time has tided us over a few of the absurd prejudices which are as so many stumbling blocks to telegraphic progress; and then the gallant Captain may expect to share the fate of all discoverers—detraction, if not disputation about the laurels.

More cannot well be said in its favour than has been advanced by abler pens than mine: pass we on, therefore, to other matters concerning cable submersion.

An experienced seaman ought to be the best judge as to the description of cable most suitable for any given locality, and he should be sufficiently acquainted with the general construction thereof as to give a little information by way of suggestion, when the subject comes on for discussion. But here we regret to observe that all our marine authorities appear to be on the unsatisfactory Carlylian system of pulling to pieces without exhibiting the slightest competency to reconstruct. He is doubtless a clever man who succeeds in proving that to be abominably and irretrievably defective, which we, good, easy, confiding souls deemed perfect, *sans* spot or blemish. But it would argue a more commendable quality than mere cleverness if we could be shown how the imperfect could be made more complete, or otherwise be superseded by that which should be introduced in its stead by the beneficent dissector. Nautical authorities, however, while they denounce, or take exception to every existing style of cable, seem utterly unable to give even so much as one single idea as to the thing they would prefer; or if a recommendation is broached the reservation by which it is accompanied evinces only the state of dubiousness existing in the mind of the person who makes it, and therefore it is by no means safe to be acted upon. And Captain Selwyn is no exception in this matter; the most we can get at from him is, that a cable of medium weight—neither too heavy nor too light—is the most desirable, but this is very vaguely put, and may mean a variety of things, according to the notions of the different individuals to whom the statement presents itself.*

In common with all sensible, unprejudiced men, he repudiates spiral iron sheathing, for excellent reasons, which, however, I need not specify, since the readers of this journal must by this time be pretty familiar therewith. We cannot, however, dispose of his objections to light cables so easily. It is a novel reason of his own that the Captain urges against them—viz., that the length of time required in sinking exposes such cables to the disastrous influence of surface currents, as well as currents beneath the surface, but how deep down doth not appear. But all this is founded on the supposition that the ship should be going at a rate of not less than five miles an hour, while the cable would only sink at the rate of two miles in the same time, thus leaving three miles floating, we are told, on the surface, exposed to all the real and imaginary evils its untoward position subjects it.

But why should the vessel scud at the rate of five miles an hour across the ocean if the safety of the cable is imperilled thereby? And where and how is the danger incurred by accommodating the speed of the vessel to the sinking qualifications of the cable? And what is the nature of the danger? Does it concern the ship and crew, or the cable only? "Slow and sure," I should think, were an excellent maxim to act upon in this case as in most others, for I know of nothing that requires greater care and avoidance of undue haste, than the manufacture of a cable, and certainly the same holds good with respect to its submersion.

This necessity of sailing at a certain speed, which shall be a minimum, truly seems most extraordinary; but we are not shown why it is necessary, nor wherein the danger lies of reducing your speed to the nature of the cable you have to lay; if this had been done we should then be in a position to decide which were the lesser of two evils; that is, the unknown evils of a "slow coach," which we should be glad to be informed about, and the contrary evil of scudding along at a rate which shall leave miles of cable floating prone on the surface of the fishy flood, thereby risking the breaking thereof into no end of fragments; and further, whether it were worth while to run either risk. But it is assumed that the vessel must sail at the above rate, and the danger, therefore, to a cable is in having to withstand the force of a current by virtue of its tendency to float for a continuous space of three miles at the stern of the vessel. It by no means appears, however, that a cable of light specific gravity (¾ to 1 ton per mile, for instance) would float upon the surface for any considerable distance, and if it did it could only be for a very short time, for a gradual sinking must be going on along the whole length of what is paid out until it has reached its final resting-place at all points. Consequently, if a surface current be met with, its effects could be partly counteracted by paying out slack at that particular spot, so that the strain brought to bear upon it should have a greater length upon which to expend its force. The disastrous effects of a current, or currents, would have to be encountered by any cable, light or heavy, and however paid out; nor can I see why the former should not be as well capable of withstanding its effects as the latter, since the tensile strength of a cable does not necessarily depend upon its weight, but principally upon the materials of which it is composed; and further, however strong the current assailing it, transversely we will suppose, it does not of necessity hinder its gradual descent; and if plenty of slack be allowed at the time, we are safe in assuming that it will slowly but surely sink out of reach of its influence; and as these are only occasional evils (for I presume the ocean is not one adverse current, nor yet an endless succession of currents, from which there is no escape), why, with proper precautions, they may turn out to be not so very formidable after all: but this is not all based upon the

* [Capt. Selwyn lays down as distinct law, "that the cable must be calculated for the depths in which it is to be laid. That its suspended weight in water must be as nearly as possible half the breaking weight," &c. This is far from being vague.—ED. E.]

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supposition that the vessel must steam away at the mimimum rate of five miles an hour. We return, however, and again put the question, why is this speed necessary? I am satisfied that a light cable not less than ¾ and not exceeding 1 ton per mile, is the most suitable for long and deep-sea telegraphs, supposing it to be constructed on rational principles; and I am satisfied that so important a work as the laying of a cable, should not be hurried. Surely, it were wiser and safer to make sure of your work as you go on, though the voyage should be trebled in duration, than that the hurry-skurry, helter-skelter system should be followed in any respect, since it is unquestionably fatal to the work taken in hand, whatever it may be; and does not the old Atlantic cable add its silent and weighty testimony to this truth. A speed of three miles an hour would scarcely be a three weeks' voyage across the Atlantic, and some people would jump for joy to see a cable successfully laid in so short a time, or even another three weeks at the end of it; and we are justified in believing that a still greater extension of time would ensure a more effective success, inasmuch as with the assistance of Captain Selwyn's floating cylinder, a comparatively light cable could be paid out, and sink gradually with but little difficulty, without any artificial appliances. M.

MR. R. S. CULLEY ON RAILWAY TELEGRAPHS.

Extracted from the Abstract of the Discussion upon Mr. W. H. Preece's Paper read before the Institution of Civil Engineers, Jan. 13, 1863.

Mr. Culley said, he had no system of his own to bring forward, nor even a pet scheme to defend; but for the last seventeen years he had been intrusted, at different times, with the management and maintenance of the Electric Company's telegraphs and of systems of train-signalling, in Scotland, and on almost all the lines of railway in the West, the Midland Counties, and the North-West of England. He had consequently visited a large number of tunnels, and had been able to learn from the signalmen in charge what they had most confidence in. He had found the system of permanent signals preferred to those in which the same wires were used for both lines of rails, and by which trains were simply "reported" as in or out of a tunnel. It was true that the want of a permanent visible signal was in some measure compensated for, by the entry of each signal in books provided for that purpose; but unless the entry was made at the moment, there was danger that it might be neglected, and the book be made up afterwards. At Springwood, near Huddersfield, there were two tunnels, connected by a short open cutting, in which cutting was a junction with another line—a most difficult point to work. There were three cabins with telegraphs. So much were the men impressed with the necessity of having a permanent signal, that they invented one of their own, consisting of a piece of red rag placed on the instrument when there was a train in the tunnel, and removed when it was reported clear. This red rag was, he believed, now replaced by a card. Generally speaking, he found temporary signals were adopted for the sake of economy; but it was not so in the instance to which he referred, for double-needle instruments were used, and one wire might have been appropriated to the up line and the other to the down line without extra expense. He had heard that the block system was about to be adopted at this place.

Bells to indicate "line clear," or "line blocked," seemed more objectionable than the system of temporary needle signals; because the eye was more to be depended upon than the ear. He had never had to maintain a bell-system; yet from what he knew of bells, he should be sorry to trust the safety of the line to the accuracy of observation of the number of strokes. He merely ventured this general opinion, as he might be prejudiced in favour of the needle. He had not any experience of the working of Mr. Walker's system, but from what he had heard of it, and from what he knew of the apparatus used, he believed it was the best bell-system that had been introduced.

Mr. Preece had omitted to mention, in his description of the block system, as used at the Clay Cross tunnel and elsewhere, that when the signal "line clear" was given, on the exit of the train from the length protected by the telegraph, it should be repeated, or acknowledged by the man at the end at which the train had entered. This repetition was the safeguard against error, and against failure from demagnetization, reversal and accident to the wire, or the apparatus. He was aware that it was not always insisted on, for a few months since he had heard of a narrow escape. At the place he referred to, the "block was taken off, by simply releasing the needle and allowing it to remain upright. The instrument at the cabin towards which the train was running happened to fail, the needle dropped, but the man very promptly managed to restore the current, although not until the semaphore at the end by which the train entered had been lowered. But if the correct practice had obtained at this tunnel, the sudden failure of the block would not have led to the lowering of the semaphore. It would have been seen that there had been no reversal to "line clear," and on trying the instrument, it would have been at once perceived that something was wrong. If the needle were even first reversed by lightning, so as to give a false "line clear," and then at once demagnetized, it would be discovered in the act of acknowledging, or of repeating the signal. If demagnetized the needle would not answer the handle at all; if reversed it would move in the contrary direction to the handle. Mr. Edwin Clark's system required permanent currents, and enabled three, instead of two distinct signals to be given. It also allowed of the danger signal being sent from any part of the section. He had no recent experience of Mr. Tyer's system. He had charge of it some years since on the Great North of Scotland and on the Furness Railways. Each system had its own peculiar faults and advantages. It was, in his opinion, most important that the faults should be similar to those of the other telegraphs on the line, so that the man in charge should not have a new set of symptoms to learn. It was an objection to Mr. Tyer's system that its faults were peculiar to itself, and required a special training; this objection might not be very serious, but it had its weight. Mr. Preece's system could be easily maintained by any ordinary lineman accustomed to alarums. Tunnels were generally difficult of access by the telegraphic superintendents, and few trains could be found which stopped even within two or three miles. But if a simple apparatus were used, the signalmen themselves could attend to it. They could be trusted to clean the batteries, to magnetize the needles, and to replace a broken wire. It was rarely the case that this class of men could not be trusted so far, whereas a less simple apparatus, however beautiful or ingenious, could not be left in their hands.

If it were really desirable to assimilate the telegraphic to the ordinary signals, Mr. Preece had most effectually and ingeniously met that requirement. Mr. Culley could not agree with those who condemned the electro-magnet, because it gave no notice, but failed suddenly. It could not be denied, that the needle was superior in this respect, but an intelligent man would not fail to discover symptoms of lessening power, in the gradually decreasing force with which the arm was lowered. The electro-magnet could not of course be demagnetized, or reversed, and even if the current failed to attract the armature, no accident would result from the failure of the current, for Mr. Preece had very properly arranged, that the current should drop the arm instead of raising it. He considered the needle system had an advantage over the electro-magnetic system, and those of Mr. Tyer and of Mr. Bartholomew. He thought the danger from the demagnetizing of the needles had been overrated, and that it might be considerably reduced by using longer needles. When the Electric Telegraph Company first started, needles six inches long were used, which only required to be magnetized about once in six months. The needles now employed were only one inch long, and they required magnetizing very frequently. The advantage of the shorter needles was the greater speed with which they could be worked, and persons accustomed to work the instruments were slow to adopt the longer needle, even where quickness of signalling was not important. He had obtained permission to place longer needles on the Edinburgh and Glasgow Railway, because those instruments being used for trains, and the men not being able to magnetize the needles themselves, it was desirable that the needles should not be liable soon to get out of order; but he had considerable trouble in keeping them on the line, because those of the men who had been telegraph clerks found they could not converse with their accustomed rapidity.

The system of signals at the tunnel on the up side of the New Street Station, Birmingham, had been referred to, as requiring an unnecessarily large number of wires. The author of that system would perhaps permit him to give a brief explanation of it. The tunnel was at the foot of a steep incline, leading from the junction of the London, with the Manchester, Derby, and Bristol lines. There were points and crossings at the station enn of the tunnel, and even in the tunnel itself; and the trains from the different lines had to be shunted to their respective platforms. It was necessary then, that the pointsman should know accurately what train was coming. It was thought undesirable to indicate the trains by beats either of the needle or of the bell, because a signal, if misunderstood, might cause a train to be sent on to the wrong line; and it was considered necessary to have a particularly distinct signal. There was first a double-needle instrument, to indicate the description of the train. The movement of the left-hand dial to the right indicated the main line London train, and to the left the Midland train. The other signals related to the South Staffordshire line, and to goods' trains. When a train reached the ticket platform near the top of the incline, the first step was for the

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man at the ticket platform to block his indicating needle over to the name of the train coming down; thus asking the man at the other end whether the station was clear, or not, for that particular train. The reply was given on a third dial (showing only the two signals "line clear" and "line blocked"), by the pointsman at the switch box blocking his handle over. The signal indicating the description of the coming train was kept on, until it had passed the station points, when the pointsman took off the block, and the man at the ticket platform released the indicating needle. He was informed that, even with these precautions, it had been found necessary to introduce a supplementary pair of wires and dials for the ordinary block system, making five wires in all. Extreme safety was thus gained, and though there were many wires, each had its special use, and had been found in practice to be necessary.

THE FRANCE AND ALGIERS SUBMARINE CABLE.

FROM the very deep interest which has always been felt for this cable, owing to its being the only really deep-sea telegraph which has, up to the present time, been a lasting success, we have been induced to inquire very minutely into all the circumstances connected with its failure, in order that they may be fairly estimated and considered, so that this may not be set down hastily as a check against the further development of submarine telegraphy.

The cable was commenced and successfully laid from Algiers as far as the Island of Minorca, in September, 1860, and worked, in connection with the Spanish lines, until September, 1861, when the second section to Port Vendrees, in France, was completed and joined up, the entire length requiring but four ordinary battery cells to work the constant day and night stream of messages, the receipts from which, even in the comparatively short time the cable has been at work, have more than repaid the capital expended on it.

On the 25th of November, and again on the 13th of December last, there were very heavy gales in Algiers, accompanied by lightning, and two separate faults were reported to the French telegraphic administration, and greater battery power was used to try and work through. The paddle brig of war *Brandon* was detailed with M. Ailhand and his staff, to try to repair it. Their first tests indicated the fault near Port Vendrees, where it was lifted and cut, but their tests then gave it near Minorca, where M. Ailhand again lifted the cable and cut it, carrying the end of the Port Vendrees section into Minorca, and dropping the end of the Algiers section into the sea. Their further tests then gave the fault near Algiers, where the cable was underrun to a distance of 2½ miles from the shore in 85 fathoms water, until they reached the main hemp and steel cable. After this the water deepened very rapidly, and they cut the cable, joined it up again, and dropped it, as their appliances would not allow them to underrun further. The French administration then applied to Messrs. Glass, Elliott, and Co., to allow their steamer, the *Hawthorns*, which was then in the Mediterranean, to proceed to their assistance, and on her arrival at Algiers on the 29th of January, Mr. Canning adopted the following course of proceeding at the wish of M. Ailhand—that the *Hawthorns* should go to Minorca to find and test the end of the Algiers section, and to pick up some cable there, and that the *Brandon* should go to Toulon for more cable, so that on their return to Algiers the *Hawthorns* would have sufficient cable on board to lay in a new piece should she reach the fault off that place.

The tests by M. de Sauty, from the Algiers end, showed either a break in the cable or else that the copper was exposed at a short distance from the shore.

The *Hawthorns*, when at Minorca, found the end of the Algiers section about 1½ miles nearer the shore than the position pointed out by the *Brandon*; and the iron cable recovered which had been underrun by that vessel had evidently been handled very injudiciously, and not as a delicate submarine cable ought to be used. The tests from Minorca showed a second fault about 90 miles towards Algiers.

Returning to Algiers, the *Hawthorns* grappled the cable off there, underran it to the junction with the main cable, cut it, and commenced to pick up towards the first fault, but only 150 fathoms after the splice made by the *Brandon* had been lifted, when the end of the cable came up without having shown the slightest indication of strain on the dynamometer, and being quite slack. Depth of water 85 fathoms, and soft blue mud bottom. The end being carefully examined, the outer wires proved in very good perservation, and from their appearance had evidently been broken by the *Brandon* in making the previous splice, as they were drawn in like a kink, and the cable had been dragged a long way to the eastward of the course in which it was originally laid.

As the soundings gave a depth of 260 fathoms only half a mile further out to sea, and as the weather at this season is very much against these operations, it was decided that the attempt to reach the fault for the present should be abandoned.

From the faults having shown themselves immediately after heavy gales with lightning, it is the general opinion that lightning has been the cause of failure in this cable, especially as there were no lightning conductors in circuit with the cable and land lines, as, even for the short time the cable was landed at Minorca in 1860, during a violent storm of lightning, the lightning conductor, which at that time was fortunately in circuit, was fused: and had it not been for this safeguard the cable would at that time have been seriously damaged or rendered useless.

Taking the whole circumstances into consideration, we are led to believe that had the ordinary precautions—lightning conductors—which are used with almost every other cable, been in circuit here, the Algiers cable would have been still successfully working; or when the faults were first shown, had a vessel throroughly fitted with the proper appliances for these operations been sent out, the first fault off Algiers could, we think, have been cut out, and it would then have been more than possible with the usual battery power to work through the second fault, and we should not now have to announce the loss of what we hoped was a really lasting deep-sea telegraph.

The cable that has been picked up is in an excellent state of preservation, and is nearly covered with marine incrustations. The section of cable from Minorca to Port Vendrees is still in good working order, but it is commercially useless, so long as the Algiers section is silent. —*From the Correspondent of the Daily News.*

PRICES CURRENT OF INSULATING MATERIALS.

INDIA RUBBER.

Para First Quality	1s. 11d. per lb.
Second „	1s 4d. to 1s. 9d. „
Third Negro	1s. to 1s. 2d. „
Java	1s. 4d. to 1s. 5d. „

GUTTA PERCHA.

Fine	2s. 6d. and above.
Genuine	1s. 9d. to 2s. 3d. per lb.
Reboiled good	1s. 7d. to 2s. 0d. „
Inferior Reboiled	1s. 0d. „

March 18, 1863. WM. KIRKMANN,

4, *Howford Buildings, Fenchurch Street, E.C.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of THE ELECTRICIAN.

SIR,—I have observed in your impression of the 6th, inst. a letter signed by Mr. F. N. Gisborne, referring to the attacks of marine animals on gutta percha.

As he states that the specimen he alludes to was shown him by my late partner Mr. Lionel Gisborne, I cannot do better than give you, as under, a copy of a memorandum written by Mr. L. Gisborne, dated the 29th July, 1859, which probably refers to the same specimen.

For myself, I have, I believe, seen every specimen of gutta percha brought into this office, and have never seen, here or elsewhere, gutta percha "perforated through and through" as described by Mr. F. N. Gisborne. Mr. Lionel Gisborne's memorandum gives a fair description of all the specimens which I have seen.

(COPY.)

"Memo. on gutta percha picked up between Syra and Candia. June, 1859.

"Werner Siemens showed me a piece of gutta percha cut off the hempen covered cable, laid a part of the distance between Syra and Candia.

"The surface was eaten over thickly into small holes, three or four times the size of a pin's head, and a 32nd of an inch deep. It looked pitted with pock marks. He states that the hemp covering was also eaten, and was quite rotten; that there were numbers of animals in the hemp and on the gutta percha; one sort is a worm, another is more like the *teredo navalis*, but smaller, with a shield over its head. The portion of the same cable covered with iron was quite sound.

"The depth in which these animals and their depredations have been found, varies, from 50 to 250 fathoms, but he does not believe they exist at 1,000 fathoms.

"We examined this gutta percha in a microscope, the edges of the hole were rough, the gutta percha being, apparently, torn into thin strings or threads before the animal eats it. The holes were smooth in the bottom and oval or round, the largest being about this size (O); it did not appear that the first coating of gutta percha had been anywhere eaten into; the second or outer covering of gutta percha being alone injured; there was

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a film of Chatterton's compound between the two coatings of gutta percha, and it appeared to be uninjured. (Signed) L.G. 26 July, 1859." I am, sir, your obedient servant. H. C. FORDE.

6, *Duke Street, Adelphi, W.C., March* 11, 1863.

To the Editor of THE ELECTRICIAN.

SIR,—A friend of mine lately mentioned to me "that a current of electricity passing along a wire of any metal causes it to shrink, and would instantly on breaking contact return to its former position."

Having heard the above, it instantly occurred to me that I might make, by the use of this principle, a simple contact breaker for an induction coil, or any instrument where the currents are required in rapid succession. I therefore planned out, after a little consideration, the instrument I am about to describe, and shall feel extremely obliged if you or any of your numerous correspondents would point out any means whereby I might improve and simplify it.

Being a student, and a reader of your valuable articles under that heading, I have followed your advice by using gutta percha for the stand. I employ a piece of middling-size copper wire, about a foot in length, and fasten one end to the gutta percha slab, and bring it through and connect it to a binding screw. I then lay the wire horizontally on the slab and place the end in contact with a piece of metal fastened firmly in the slab and brought through and connected to a binding screw. Therefore, when I join the poles of the battery to the binding screws the current traverses the wire from one screw to the other, and causes the copper wire to shrink, and thus contact is broken, and, according to my friend's theory, the wire will instantly return to its position, and so making and breaking contact alternately.

It is a very simple plan, and if it succeeds it would save my fellow students a great deal of trouble and expense in making the *contact breaker* for their induction coils.

I must also thank you for answering my rather numerous questions, and apologize for troubling you so often.—I am, yours obediently,

J. R. O.

P.S.—If the above description of my plan should appear rather unintelligible (as I am very much afraid it will) to any of your readers, I shall be most happy to forward them a drawing of it.

To the Editor of THE ELECTRICIAN.

DEAR SIR,—Can you inform me if it is possible to obtain an electrotype shell of nickel upon a blackleaded wax mould? and if so, what solution should be used? I have been trying a solution of chloride of nickel, but although I have succeeded in obtaining a deposit, it curls up in scales as fast as it is deposited—Yours truly, STANHOPE.

Barnsbury, March 14, 1863.

[We have successfully deposited nickel from a solution formed as follows:—The pure metal is dissolved in nitric acid, and oxide of nickel precipitated from this solution by means of caustic potassa. The oxide, when washed, is dissolved in a solution of cyanide of potassium.

Rather high battery power is required, and an anode of pure nickel. Should you not find this process satisfactory with the moulds you use, we will indicate another method.—ED.]

To the Editor of THE ELECTRICIAN.

SIR,—I had in contemplation a series of experiments for producing self-sustaining voltaic batteries, with similar metals for positive and negative plates. The first I attempted, was with copper for the positive, in a solution of nitric acid, and a piece of the same copper in porous cell charged with a saturated solution of nitrate of copper, made by saturating nitric acid with copper until it would dissolve no more; this I used for the negative solution. I placed an extra piece of copper in this solution besides the negative of copper, to keep the solution saturated; the extra piece of copper was not in contact with the negative plate. Now, I imagined that the nitric acid solution (which was about one part water and one acid), would act upon the positive plate, and cause a current to circulate towards the negative plate and reduce the nitrate of copper solution on to the negative plate, which solution would be kept thoroughly charged with copper, (should any deposition of copper take place, by the extra piece of copper in the negative cell); at the same time I should have a solution of nitrate of copper forming in the positive solution to be used for other negative exciting solutions, so that the only expense in this arrangement would be nitric acid. Now, as there was no action on the negative plate, I concluded I should have a very constant and powerful current of electricity, but, on connecting for a current, I found there was no more than would have been produced by a single couple of zinc and copper. Although the current did not come up to my anticipation, I ascertained that a current *could be produced* and would no doubt last a considerable time. There was no apparent action going on in the positive solution on the positive plate, so that perhaps the solution was not strong enough. I had intended to try the following metals under similar conditions, but not being satisfied with the first attempt, I have taken the liberty of asking you whether I am in the right track or merely following in others footsteps. I will now give you a list of the metals.

For Positive			For Negative		
Lead	...	Acetic acid	Lead	...	Acetate of lead
Iron	...	Sulphuric acid	Iron	...	Sulphate of iron
Zinc	...	Sulphuric acid	Zinc	...	Sulphate of zinc
Tin	...	Muriatic acid	Tin	...	Muriate of tin
Copper	...	Nitric acid	Copper	...	Nitrate of copper
Copper	...	Sulphuric acid	Copper	...	Sulphate of copper

and so on with all the metals up to gold, &c.

I cannot conceive why any of these arrangements should not act, as they fulfil all the conditions required in a voltaic combination, viz., one metal to be acted on by the solution, and the other passive to it.—I am, Sir, yours respectfully, J. COOK.

TAR AND VEGETABLE FIBRE UNDER PRESSURE, &c.

To the Editor of THE ELECTRICIAN.

SIR,—My attention has been called to a very interesting paper which appeared in the *Cornhill Magazine* for May, 1861, from which I shall make the following extract:—Referring to the pressure of water, the writer states, "As an instance of this pressure, we may mention, that in one of the soundings taken by Captain Dayman in the *Cyclops*, the tar was forced out of the rope in an extraordinary manner, several of the splices started, and the line much stretched." The condition of the line coincides in every respect with that of a length of 60 feet of the Rangoon cable subjected to experiment for tensile strength, and referred to in my last week's letter.

With respect to the effect of tension upon a hempen strand, I made the following experiment with a view of ascertaining its contractile force.

DIAMETER OF STRAND 7·32 OF AN INCH.—LENGTH 100 INCHES.—NUMBER OF YARNS 6.—DIAMETER 2·32.

Weight.	Elongation.	Return, or Contractile Force.	Permanent Elongation.
lbs.	inch.	inch.	inch.
7	·03125	·03215	·0
14	·25	·25	·0
28	·75	·625	·125
56	1·5	·563	·937
112	2·0625	··563	1·502
168	3·25	—	—
224	3·5	1·	2·5
336	4.25	1·218	3·032

I have also been informed that those employed in the whale fisheries have often observed that when the rope attached to the harpoon is drawn by the fish into great depths, that its tensile strength is considerably impaired, and in some instances completely destroyed by the great pressure to which it is subjected. The sounding lines employed in our marine surveys invariably give way when submerged in great depths, but I have not been able to ascertain whether the breaking of the lines has ever been attributed to pressure. The following question was put to Commander Dayman, R.N., when examined by Mr. Bidder before the Government Telegraph Committee. "Did you succeed on any occasion in hauling the line taut in lifting the weight off the bottom before you broke the line?" "In no case, in the great depths." In reply to another question whether he was sure that the line would break at the bottom close to the weight, Commander Dayman stated not, that it might break at any part of the line. —Yours &c., OWEN ROWLAND.

Telegraphic News.

THE official telegraph report informs us that the Swedish telegraph has net advanced from 10 geographical miles in 1858 to 689 in 1861; the total miles of wire being 983 geographical miles, while the number of stations has increased from 2 to 68. In 1861 the number of telegrams was 169,038, the income 513,044, and the clear gain to the State 69,142 Swedish dollars.—*Building News.*

IT has been proposed to construct telegraphic communication from Valparaiso to Panama. This scheme had been agitated in Santiago.

AT the Inventors' Institute, on Monday last, a discussion took place upon Captain Selwyn's paper, "On the Means hitherto Employed for Submerging Telegraph Cables," in which Admiral Sir E. Belcher, Mr. Fleeming Jenkin, Mr. F. Allan, Mr. Owen Rowland, and Dr. Collyer, took part.

WE are sorry to hear that one of the most important links in the Channel Island system of telegraphs has just failed.

UPWARDS of 50 miles of the Persian Gulf Telegraph cable have been sheathed, at the works of Mr. Henley, North Woolwich.

To Correspondents.

RELAY-MAGNET.—Too late for this week.

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The Electrician.

Vol. III. No. 73.—March 27, 1863.

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MEDICAL ELECTRICITY.

The physiological application of electricity, which for a lengthened period remained almost exclusively in the hands of empirical pretenders to occult powers derived from its agency, has of late years fully vindicated its claim to be considered as a branch of exact science. The researches of Remac in Germany, and of Hiffelsheim and Robin in France, have extended our knowledge of the subject in several most important particulars. The works of M. Duchesne,* of Boulogne, and of M. Tripier,† contain also a large amount of general information in regard to our present subject matter. In England, the efficiency, in the treatment of numerous classes of disease, of the means afforded by our science has been fully attested by the evidence and by the practice of some of our most eminent physicians and surgeons, among whom we may mention Sir Charles Locock, Dr. Pereira, Dr. Golding Bird, Doctors Radcliffe, Russel, Reynolds, James, and Thompson, Mr. E. W. Tuson, F.R.S., and Mr. Harry Lobb. It is to be regretted however, that, in England especially, there is an almost total absence of general and popular information in regard to the curative effects and the *rationale* of electrical applications. Were it otherwise, we are convinced that a great amount of physical suffering might be mitigated or removed. A few brief counsels from medical authority might enable many successfully to undertake their own course of treatment; and, in the absence of certain symptoms necessitating competent medical supervision, to employ with perfect safety the powerful physiological action of the voltaic current in diseases such as neuralgia, rheumatism, partial paralysis, contracted joints, congestions, palpitations of the heart, obstructions, strictures, some cerebral, spasmodic, and hepatic affections, &c., &c. "The more the effect of electro-galvanism is tried," says Mr. Tuson, the more influence it will be found to have upon the functions of the human body; and in many cases of long standing, where the patients are afflicted with disorders that have resisted the effects of all medicinal agents, electro-galvanism will often prove most efficacious, and frequently tend to give relief if it does not cure the malady; but in such cases it ought to be applied by those capable of observing its effect, and be so regulated as to be productive of no ill consequences. It is a most successful and influential agent, and the more we study its influence, the more we shall be pleased with its surprising and wonderful effect."

The frictional machine for generating electricity, which is now generally considered inadmissible in the treatment of disease, was at the onset the only source employed for this purpose. It was supposed that by means of this machine the electricity in which the patient was deficient might be supplied to him, or that a superabundance of electricity in his system might, on the other hand, become neutralized. These ideas, and the effects presumed to follow from the communication of the electric fluid by means of rods of gold, &c., have never been seriously entertained by science; but the electric commotion or shock, showing the presence and action of an artificial auxiliary to the nervous agency, was at all times an interesting phenomenon to the medical profession. Thus it was that electricity became successfully employed in the treatment of paralysis, a disease which appeared obviously to have its origin in the interruption of nervous circulation. The discovery of Volta offered a far more effectual means of supplying a continuous stream of electricity to excite and vivify the diseased organs; and though the inconvenience and expense of a battery of a large number of cells led to the adoption of other apparatus, it is questionable whether any of the latter can advantageously replace the simple voltaic series. We shall see that this may now be employed without any of the inconveniences which attended its early application.

The discoveries of the magneto-electric machine and the induction coil were nevertheless of great advantage to electro-therapeutics. The former is essentially composed of a coil of wire surrounding a bar of soft iron, which becomes rapidly magnetized in opposite directions through the inductive action of a rotating permanent magnet. At each change in the magnetic condition of the soft iron, a current, which may be of very high tension, tends to traverse the coil of wire. The voltaic battery is thus altogether dispensed with; and by certain arrangements the current may either be rendered intermittent in contrary directions, or continuous, like that from Volta's arrangement. The magneto-electric machine, however, requires manual labour, and in this respect offers no advantage over the frictional machine. It has therefore been almost wholly superseded by the form of induction coil we have now to describe.

In the medical coil machine, a bar, or a bundle of wires, of soft iron, is rendered magnetic by the passage of an electric current from a single voltaic couple through the *primary* coil of stout copper wire, which surrounds the core. This portion of the machine, the *electro-magnet*, is due to the researches of Arago, Sturgeon, and Henry.

Upon the primary coil is wound the *secondary* coil, formed of a considerable length of fine copper wire. At the moment when the circuit of the battery is completed through the primary coil, and also when the battery current ceases, an induced current of comparatively great power tends to traverse the finer coil. The discovery of this fact belongs to Faraday.

As the induced current occurs only when the core of soft iron is acquiring or losing its magnetic power, it is necessary that the current through the primary wire should be rendered intermittent. This is effected by the *contact-breaker* contrived by De la Rive. When the core has become magnetic, it attracts a piece of iron mounted upon a spring, and by this means interrupts the continuity of the primary wire, and breaks the current: when the core loses its magnetism the iron armature springs back and again completes the circuit of the battery. The armature thus vibrates with great rapidity, and a succession of currents in opposite directions traverse the secondary wire.

The *regulator*, an important addition to the medical coil machine, is due to Professor Henry. It consists of a hollow cylinder of copper or brass, immediately surrounding the soft iron core, and capable of being withdrawn longitudinally to a greater or less extent, according to the degree of power required in the induced current. When wholly withdrawn, the tension of the current is at its maximum. The *modus operandi* of this appendage is often imperfectly understood, and is therefore deserving of special notice. It is to be observed that, if a narrow longitudinal slit be made in the tube, from one extremity to the other, or if it be constructed of non-conducting material, it becomes inoperative. The common explanation, that the regulator simply cuts off the magnetic effect, is therefore defective. The efficiency of the contrivance is due to its being a "closed metallic circuit." It is remarked by Poggendorff, that any closed circuit surrounding, either interiorily or exteriorily, a coil under inductive action, retards this action, and diminishes considerably the tension of the induced current." That this should be the case in the present

* Traité de l'électrisation localisée, 1 vol. Paris, J. B. Baillière.

† Manuel d'Electro-Thérapêe, 1 vol. Paris, J. B. Baillière.

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instance is obvious, when we consider that the current in the primary wire induces a current in the opposite direction in the "closed metallic circuit" of the regulator, and that the effect upon the soft iron core and the secondary coil thus becomes to a great extent neutralized. In accordance with these data, we may construct the regulator of insulated wire, coiled in the form of a hollow cylinder; and, if the extremities of this wire be brought into metallic connection, it will be as effective as the tube of metal, while the contrary will be the case if the extremities be disconnected.

It will be seen that nearly all the great modern discoveries in electricity have found their application in therapeutical science.

We have now to advert to the capital fact, due to the recent researches of M. Wiffelsheim, made in conjunction with the antomist M. Robin, that the physiological effect of a continuous circuit is diametrically opposite to that of an intermittent current. The latter is an *excitant*, it contracts the muscles and diminishes the action of the muscular system: the former, on the contrary, is a *sedative*, relaxing the muscular system, dilating the capillaries, and increasing their circulating power. It is to be observed, however, that the continuous current from an ordinary battery of the requisite tension approximates in its effects to the intermittent current. To obtain the sedative effects of the continuous current, it is necessary to employ a voltaic series composed of a large number of alternations of small dimensions, or offering considerable resistance to the passage of the current,—such as the *galvano-piline* of Mr. Pulvermacher. This arrangement offers the additional advantages of being eminently portable, and of being readily charged and maintained in activity for any requisite period without necessitating the use of mineral acids or the expenditure of time and trouble.

The following is one of the simple and conclusive experiments performed by the above-mentioned *associés*. A small incision was made in the abdomen of a frog, and the mesentery being withdrawn was spread out upon a small ring of cork, which was then placed under the microscope. The circulation within the highly magnified capillary vessels was thus rendered beautifully evident. The poles of the voltaic apparatus were then brought into contact with two opposite points upon the membrane. At the moment of the completion of the circuit, the vessels were observed to contract, and the circulation to be impeded. Immediately afterwards, and while the current was continued, the capillaries were visibly dilated, and a greatly increased circulation was maintained with perfect regularity. By means of the micrometer, the augmentation in the calibre of the vessels could be accurately determined. The relaxation of the tissues was in perfect harmony with the sedative effect that M. Wiffelsheim had found to be due to the action of the continuous current. The observation has the merit of perfect originality; for electrical action had been considered necessarily to involve contractile effect or muscular excitation.

Thus, *en resumé*, we find that in electricity we possess a duplex power of influencing physiological action. We desire that this fact should not remain comparatively barren of application; but that electrical science should take a great and worthy part in the alleviation of human misery.

ON THE LAWS OF ELECTRICITY IN MOTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from p. 229.)

It would be a great mistake to suppose that my formula, cited in the leading article of last week from the preceding number, was intended to replace any of the formulæ of Ohm, or even to be applied exclusively to the voltaic *circuit* at all, its object being to express the capabilities of homogeneous conductors of electricity, universally as found to result from every physical theory of electrical action, without taking any cognizance of the mode by which electricity is either supplied to the conductors or removed from them—without, in short, distinguishing whether they be in use for dynamic or for static purposes. The symbol T, therefore, cannot have, as alleged, the least analogy to the E used by Ohm to represent his force of the electromotive apparatus, all allusion to which it absolutely excludes; *motive tension*, according to my Definitions, being simply a difference of intensities, or electrical conditions, static or dynamic, in each of the conductors, however that difference be set up or maintained. And, confining the formula to its legitimate purpose, L^2 exactly represents the physical action in a conductor, *its whole length being simultaneously at work;* the expression, by the definitions could become L only on the supposition that *equal quantities* of electricity were passing along conductors of different lengths. It does not necessarily happen that the quantities of electricity sent into conductors of unequal lengths shall be always in proportion to their lengths, because the intensities of induction may vary, and the quantities are equal only when the intensities are so; therefore it may often appear that Professor Thompson's law of the squares of the lengths is practically departed from, when, in fact, such is not the case, that law, as my Definitions explain it, always assuming that the quantities are proportionate to the lengths. I may remark that under this view, much that is indefinite and even contradictory in the evidence adduced before the Submarine Telegraph Committee, becomes perfectly intelligible.*

Now that I have set the Editor right upon what he misconceived to be the culminating point of my inductive inferences with relation to the voltaic circuit, and thus rendered unnecessary any remark upon the formula he has erected upon that misconception, I might pass over the advice founded upon it. But I will just stop to say that the suggestion itself clearly shows that my object in writing these papers is not yet fully understood. I hope publicly to take into consideration the fluid resistances and all the remaining parts of a circuit, but certainly not before I can say something more about them than is already known; not until, by following out the principles which have hitherto served me so well, I shall have successfully laid open the physical theory of voltaism, and then be in a position to proceed with calculation on acknowledged mechanical principles. Even that task may prove shorter, and a less insurmountable difficulty than is imagined; at all events, its achievement is, in my estimation, so necessary to further progress, that I shall attempt it immediately after I have properly disposed of this first instalment—the external portion, as it is called—of the physical theory of the voltaic circuit; and as I have been able to trace the physical action in one part of the circuit with a detail and exactitude perhaps seldom surpassed in any other science—certainly, hitherto unequalled in electricity—down to the boundary line which seperates static electricity from dynamic, with its attendant chemical actions, I have no apprehension of being abandoned by my principles when I shall essay to step with them over that boundary; my fear rather will be, judging from past experience, that I may not have power to keep pace with them, and that the further I proceed in their company, the more sensible I shall become of a want of better qualification, and of greater leisure, for the pursuit I am alone in undertaking.

To prepare for the investigation of the physical theory of voltaism, I now submit a revision of my Definitions, embodying what before was omitted, as promised in my last communication.

Definitions Relating to Electrical Conductors in general, including Electro-Telegraph Wires and their Terminal Instruments.—I. Electricity and its Normal Relation to Matter.—The equivalent theory regards electricity as a ponderable fluid,† attracted

* [Vide *Electrician*, p. 215, *et seq.* The formula of Mr. Laming is there evidently given as expressing the signalling power of the current under varying conditions. Electro-motive force is simply "motive tension;" and, however the intensities of induction may vary, the *signalling power* (I or T being constant) is always proportionate to the sum of the resistances in the circuit. We really are at a loss to perceive that Mr. Laming's formula, however it may be limited in its application, is expressive of fact.—Ed. E.]

† The gravity of electricity claims to be a *fact*, proved by suspending it to the scale-beam under circumstances that the leading electricians of the Institut de France pronounced faultless. The experiment, repeated many times to their entire satisfaction, showed that a body falls more forcibly towards the earth when it is electrically plus than when minus, all interferences by what is known as electrical attraction being effectually guarded against.

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around the smallest parts of all common matter in definite quantities that are represented by their respective weights, and as being probably the sole cause of those weights.

The matter of electricity is supposed to consist of particles that tend to gravitate together into a mass, which—1stly, they are prevented from doing, in the normal condition of things, by the attraction they exercise for the common matter to which they respectively belong; and which, 2ndly, they immediately do when they are disconnected, and sufficiently removed, from their equivalents of matter.

All the ultimate particles of matter being assumed to be spherical atoms, particles of electricity are conceived to surround each common particle in the form of successive concentric shells, the last or outer shell being occasionally perfect, but more generally imperfect to a greater or lesser extent; and the degree of completeness of the external spherical shell of electrical particles is regarded as perhaps varying with temperature, by reason of a transfer of individual particles from one shell to another, when those shells either contract or expand.

Whenever two imperfect external shells intersect each other, the intersection places part of the electrical equivalent belonging to each of the centres of common matter nearer to the other centre than is a corresponding part of its own electrical equivalent; whereby particles of electricity in the two imperfect external shells become *in part* attracted by two centres, thus establishing the bond of union which is called cohesion when the centres have the same nature, and chemical affinity when their natures differ.

The theory admits of an union even closer than is effected by this intersection of external imperfect shells; for it is possible, in certain cases, for perfect shells to come into contact while still surrounded by imperfect shells, giving rise to other known conditions of matter which it will be sufficient at present only thus to show are provided for.

2. Induction.—Whenever two unlike centres of common matter, which have been adhering together by the electrical bond of union, are separated by mechanical force, one of them may become plus and the other minus; for each of the particles of electricity that constituted the bond is indivisible, and may have been attracted unequally by the opposite centres. *Induction* is the projection of electrical attraction—not from one to the other, across the increased distance, for that would be still normal electrical attraction, but between the plus electricity of one of the two centres and some foreign common matter at a lesser distance than its former associate; and also between the minus matter of the other centre and foreign electricity less far distant from it than the removed portion of its own. By this induction common matter and electricity still attract each other in equivalent proportions at the smallest possible distance. The term is applied to all similar action of bodies electrically plus or minus, however they may have acquired their respective electrical conditions.

3. Charge.—A centre of common matter whose series of shells of electrical particles terminate externally with a shell that is imperfect may attach around it, *within its imperfect shell*, other foreign particles of electricity, without attracting in the whole more electricity than its natural equivalent. For as many electrical particles as find places vacant in the imperfect shell will each have part of itself nearer to the centre of force than the whole of any one particle of electricity previously existing there, that part—and that part only—being attracted by the centre. A centre thus attaching around itself additional particles of electricity beyond its normal number, and no one of which in its outer shell it wholly attracts, is regarded as having a *charge*. And the same term is used in the negative sense to denote the electrical condition of a centre of common matter with an external imperfect shell from which some of the electrical particles normally belonging to it have been removed.

Charge thus collected, whether plus or minus, acts by induction; and the extent of induction afforded determines the amount of charge that may be collected, or the charging capacity, up to the limit of the number of vacant places in the imperfect shells.

4. Intensity is the force of the attraction exercised, for the time being, between any particles of electricity and the common matter by which they are held, or towards which they tend to move. The equivalent theory regards *intensity* as increasing as the squares of the numbers of electrical particles acting on the same portion of common matter. Thus, under any given extent of induction afforded, a double number of particles, plus or minus, act with a quadrupled force, and so on for all other numbers.*

5. Quantity.—This term, when applied to electrical charge, is expressive of the number of particles of electricity that are plus or minus, irrespective of the intensity with which the charge is acting.†

6. Conduction.—When electricity passes from some position to another in which it need exert a less exalted intensity, or none at all, it is sometimes *conducted*. For this to happen there must exist between the plus and minus charges, connecting them together, an uninterrupted line of centres of common matter, each centre having its external shell of electrical particles more or less imperfect. And *conduction* consists in the gliding of the accumulated electricity from each imperfect shell to the contiguous one in the direction of the minus charge, under the force of induction acting along the line, always at a uniform distance.

7. Insulation.—Electrical charge is *insulated* when it is surrounded by centres of common matter which either have no imperfect external shells of electrical particles, or, being in possession of them, have them either so impacted together as to be immoveable, or else placed by the gaseous condition so far apart as not to intersect one another.

8. Conductivity means the capacity to conduct electricity, which varies as the square root of the intensity of induction, and as the number of the lines of conduction: and also with the imperfection of the external spherical shells of the particles of the conductor, variation in the latter respect conferring upon each particle its own specific conductivity, and which may not be uniform for all temperatures.

9. Discharge.—Electricity may pass from one place to another, where it will either exert a lower intensity of induction, or else cease to be a charge, without the intervention of a conducting line between the plus and minus charges, by overleaping the distance between them. This is *discharge*, and, theoretically brought about, whenever, in the absence of conduction, the intensity of induction is made to exceed that of the attraction by which the charge is retained on the imperfect external shells of the common centres.

10. Motive Tension means the force with which charge is passed either to a lower intensity of induction, or to the normal condition of equilibrium, on an opportunity for one or the other occurring. When the movement of electricity is between centres all charged plus or minus, the *motive tension* is equal to the difference between the existing and the resulting intensities; when the movement terminates in the normal state of equilibrium the *motive tension* is simply equal to the intensity of charge; and when plus electricity moves into minus matter the two charges need to be separately calculated as though they resulted in the normal equilibrium, the two results added together, and the total taken as the *motive tension*, putting out of consideration any unbalanced charge, plus or minus, that may remain.

11. Inertia.—Electricity being ponderable matter, is subject to inertia, and cannot be put into motion without an application of force. The *inertia* of all the particles of electricity is equal, and

* It has sometimes been denied that a particle of electricity *can* act at different times with a single, or double, or a treble amount of force; but why should it not be so morally ordained? The will that can create and maintain the universe can surely determine that a particle of electricity shall increase in power with the number of the particles of electricity acting simultaneously on one and the same particle of common matter; and with that admitted to be *possible*, the whole question resolves itself into one of fact. Now, the whole range of experimental electricity abounds with facts that establish the electrical law of the squares of the quantities; while the circumstance that those facts trace physical causation back through the last link of its chain, is no small advantage to philosophy, rather than a drawback.

† The terms *intensity* and *quantity* have been confounded together in an inexplicable manner, seemingly from the fact that under certain circumstances analogous results may be produced by the two; a given quantity of electricity of high intensity becoming identical with the same quantity of low intensity on the former being sufficiently distributed. Just as in the case of light, intensity disappears as the dispersion increases, though the quantity remains unaltered. In neither of the cases, however, are intensity and quantity the same things.

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repeated each time they are forced into motion. The *inertia* in a conductor for each particle of electricity forced through it is simply as the length, because its stopping places are in number proportionate the length; and for larger quantities of electricity the *inertia* is as the length of the conductor multiplied by the number of electrical particles passing through it.

12. Antagonism is the normal retaining electrical attraction which is opposed to, and equals the *intensity* of the *induction* of each particle of plus electricity so often as it acts.

13. Velocity is the speed with which electricity moves, under the impulse of *motive tension*, either when discharged or conducted. In the former case, when once in motion, the *velocity* of electricity is diminished only by mechanical impediments to its passage; and in the case of conduction the *velocity* is the product of *motive tension* divided by the *inertia* and the *antagonism*.

14. Resistance varies directly as the *inertia* and *antagonism*, and inversely as the minimum amount of *conductivity*.

15. Retardation is the time occupied by an electro-telegraph conductor in receiving that portion of electricity which rests upon it as *charge* before the production of a signal. The conductor being given the *retardation* varies directly as the amount of *induction* afforded and as the square root of its *intensity*, that is, with the *quantity* of charge; and inversely as the *velocity*.

16. Signalling Power.—This is measured by the *qnantity* of electricity arriving at the end of an electro-telegraph conductor in a given, time. It varies directly as the *motive tension*, and as the *quantity* of electricity supplied in a given time up to the full capacity of the smallest *conductivity* at the initial *intensity*, and inversely as the *inertia*, the *antagonism*, and the *retardation*.

17. Voltaic Apparatus.—So far as the foregoing Definitions are concerned, the theory does not exempt this apparatus in any particular from submission to the ordinary electrical principles, nor invest it with any special influence on the telegraph conductor that would not be exercised in some measure by every other source of electricity. It is generally employed because it is the best means at our command for supplying in the form of *charge*, and with sufficient *intensity*, the abundant *quantity* of electricity always demanded in a mere instant of time for telegraph service—submarine in particular. For the present purpose (which does not embrace the physical cause of electro-motion) it will suffice to regard the poles of a *voltaic apparatus*, whether it be composed of a single set of elements or a greater number, as conductors inexhaustibly *charged* one by the other, plus and minus respectively, to a degree of *intensity* that may be reduced by a rapid abstraction of charge, but never, under any circumstances, increased.

With respect to a single set of voltaic elements, we must view it—1st (in conformity to universal mechanical principles), as producing an effect varying with its own dimensions operating as a cause; 2ndly (which is dictated by observation), as varying in effect with the nature of the elements of which it is constructed. When more than a single set are joined together in series, another consideration has to be added; forasmuch as one set of voltaic elements can accumulate at its plus and minus poles a given *quantity* of *charge*, so it is conceived that any other number of sets arranged in series can accumulate at its extremities corresponding numbers of equal *quantities* of *charge*, making a sum total represented by the size of the elements, multiplied by the number of sets, the intensity of the total quantity being as its squares.

ON ELECTRIC AND COSMICAL PHENOMENA.

BY ADMIRAL FITZROY, F.R.S.

Electricians are familiar with "*circuits*"—completed circuits; and will probably think a person who asserts that *a circuit may be fallacious*, only proves his utter ignorance of the subject.

Undeterred, however, by this probability, the author attempts now to show that such theories are insufficiently supported by facts, and that the effect called "completion of a circuit" is caused in a manner altogether different, and hitherto unexplained. It is well known that communication existed, for a short time, between Valentia and St. John's, in Newfoundland, *under* the ocean, through a wire or combination of wires, some 2,000 miles long; and very lately, telegraphic messages were sent from London to Corfu, also about 2,000 miles, in less than two seconds. In both cases the accounts allude, or rather refer explicitly, to the *return currents* of electricity—supposed to traverse the earth, through land and under sea, from one extremity of each great distance direct to the other—to "complete the circuits."*

To suppose that electricity darts from one point to another, immensely distant, rather than to any other much nearer recipient, at least *equally ready* to receive it, is a strain on imagination not easy to be borne.

The writer of these words has never been able to believe that such is the case, and now will offer a few considerations.

1. He has thought that electricity may be an etherial *influence*—not tangible or ponderable like any material fluid. 2. That space may be filled with such an influential ether, *infinitely elastic* and self-repellent. 3. That dry air is almost a non-conductor of its action. 4. And that *our* earth may be a vast reservoir, abounding in electricity—always ready to receive from space, while equally so to communicate to any point on earth's surface which may be less electrified than earth itself, and connected with it by a conductor.

5. Electric influence (or ether) may be cold, proportionately to its less resisted *expanse in space*.

6. Heat may be caused by compression of electricity (etheric influence), or by resistance to its expansion.

7. Matter in space, *acted on from every direction* by infinitely compressing *influence*, may become concentrated and heated, then develop a non-conducting atmosphere—and may acquire rotation in consequence of alternations and oppositions of electric influence within and without such an atmosphere, caused by heat acting against cold.

8. Under such conditions, any communication through *air*, by a *conductor*, upward or downward, from earth or from above, would facilitate electric action, which is invariably from the more electrified or influenced matter—to the less influenced—or as *usually* said, from positively electrified to negatively electrified; the *direction* of action being unimportant, *supposing that one influence only* exists, which pervades all space, and is latent in all matter, in greater or less degree.

To go now into *reasons* for these suppositions—strange, even absurd, as they may appear to some persons unacquainted with Higgins's views,† with Faraday's expression about gravitation, and with Newton's questions as to the real nature of gravity—would be unadvisable. The author ventures to write them here only to show why he believes that effects of the commonly received "circuits" of electricity may be more naturally and intelligibly explained in the following manner.

Whenever an electric effect (*usually called a current*) is to be caused through a conductor, *influence* must be generated, and accumulated by a battery, coil, or machine; and near each end of the conductor, however long or short, a wire must be "*put to earth*." The popular idea is that a current flies through the conductor, and returns through the earth. But the real effect, it is here submitted, is that earth *receives* influence sent along a conductor, and at the *same* time imparts equivalent influence to the battery end of the conductor—without which distinct and unconnected actions there could be no more transmission of electric influence along a wire, than there could be of water along a pipe of which the farther end were closed, and a *vacuum* caused by any motion of fluid from the nearer end.

Imagine 10,000 inelastic, say adamant balls touching each other in a very long inflexible tube, *just* containing them in one direct line. Suppose the nearest struck sharply, all would feel and move, but *only the farthest* would drop out—though not even then, if a *vacuum* would be caused by displacing the *nearest ball*. The popular idea of flight, as it were, of electricity—fluid or something else—from one end of a conducting wire to the other, has usually been inseparable from the thought that *particles* actually traversed the whole length, however long, through or along the metal, instead of exactly considering and fully appreciating the action of a *conductor*, through air (a non-conducting medium) or in water if sufficiently insulated—by which an electric influence can be *connected or projected*—as action of a magnet on iron filings can be conveyed through an indefinitely long wire, though that magnet would not affect them, through air only, at a few inches distance.

* Such a length—or the *interval* between *any* two stations—may be well termed a *span*!

† Comparative View, Second Edition, 1791; and his Atomic Theory.

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But the author does not deny the *appearance* of circuits caused by closing, or approximating the ends of *any* conductor, *however long*, which are actually brought near or to touch each other. He only ventures to deny the *transfer of particles* from sender to receiver—*as in the other case.*

Electric influence seems to act similarly to its own correlatives, magnetic attraction and repulsion, which afford the least complex illustration of such a mysterious power acting in *lines of force**—And where non-conducting air is *absent—as in space* beyond our atmosphere—who can say how far such influential forces may be always operating on our world—and, if so, on the universe?

Pervading all *space*—permeating all aeriform, gaseous, liquid and solid bodies—an *influence* seems to exist, ambiguously mentioned, rather than explained or defined, by the term electricity.

Between this influence, and caloric, and ether, and light, and magnetism, so close are the connections or correlations—and so indefinite are any even imaginary limits—that no man now can discriminate accurately where one merges in the other, or prove to demonstration whether each such apparent or sensible, though imponderable element, may not be but a condition or modification of *one etheric principle.*

Facts seem to indicate that such a principle (for brevity here called *etheric*, ,and referred to by the familiar term ether) must be very elastic and *self-repellent*, but attracted by matter to a certain degree—namely, the point of saturation.

Cold when expansive, hot when compressed, its cosmical tendency would seem to be concentration of ponderable matter, development thence of heat, and generation of atmosphere.

Earth's aeriform envelope, *almost* saturated with (the *influence* here called) ether, may be *slow* to receive *more*, or to part with any; therefore, with respect to *infinite* space, and to our relatively central earth, may be considered as nearly non-conducting—in fact, a very slow dielectric.

If all matter retains a certain quantity of *latent ether* (rather than caloric) pressure, compression, friction, impact or contact, may cause augmentation of sensible heat, proportionate to force or duration, or both together.

Conversely — inaction, expansion, evaporation, or radiation, may cause cold in proportion to their degrees.

Ether, from or in space, may be cold. That in earth, heated by compression and *considerably* more expansive or elastic, may always *tend* to escape, but is enclosed by our atmosphere. Hence the readiness of *earth ether* (*excessive* electricity) to replace any void in air (caused by voltaic or other electric agency), and the constant necessity of such an *extra force* to impel a so-called current along a wire, *into* the earth beyond.—"*The Weather Book.*"

(*To be continued*)

HEAT AND LIGHT FROM THE VOLTAIC BATTERY—METALLIC AND ELECTROLYTIC CONDUCTION.

THE disruptive discharge of the voltaic battery through air is dependent upon precisely the same principles as those of the Leyden battery, but the phenomena are modified by the lower intensity, greater quantity, and perpetual renewal of the force. When passing between two charcoal points, its duration renders it the most splendid source of light which is under the command of art. Rarefaction of the medium through which it passes, either by heat or by mechanical means, produces the same effects as upon the common electric spark from friction. When the poles of a powerful battery are gradually separated after contact, the discharge takes place through an interval which increases with the heating of the air by the ignited charcoal. With the original battery of the Royal Institution of 2000 plates, the discharge passed through four inches of air; and with the constant battery of 70 cells, the flame is much more voluminous, and extends to the distance of one inch.

It would, however, appear that the air is not the only form of matter which is concerned in the phenomena, but that particles of the solid electrodes contribute to the general effect by convection. It is probable that the superior brilliancy of the phenomena with charcoal may be owing to the larger number of its solid particles, which its small cohesion enables it to throw off in the process.

In some experiments with a large battery constructed by Dr. Hare, the zincode was made of plumbago, and the platinode of well burned charcoal; a most vivid discharge was produced, and fused particles of plumbago were transported over to the opposite pole, which sensibly increased in length.

In other experiments which were made by the author with a constant battery of 70 large cells, a great body of flame was generated, which passed through a distance of about an inch, and the charcoal of the zincode invariably presented a cup-shaped cavity, while a considerable protuberance was formed upon the platinode of hard and brilliant carbon with a mammillated appearance. When the zincode was of platinum, and the platinode of charcoal, the latter became studded with globules of fused platinum; and when this arrangement was reversed, a considerable protuberance of carbon was formed upon the platinum platinode.

The colour of the light varies with the substances between which the discharge passes. The beautiful effects produced by the deflagration of thin metallic leaves interposed in the course of the discharge are not owing to the combustion of the metals, though in some cases increased by this cause, but arise from a dispersion of their particles analogous to that of the more momentary explosion of the Leyden battery, they equally, in both cases, take place in vacuo.

Gold-leaf emits a white light tinged with blue; silver, a beautiful emerald green light; copper, a bluish white light with red sparks; lead, a purple; and zinc, a brilliant white light fringed with red.

The disruptive discharge of the voltaic battery will take place with great brilliancy under the surface of distilled water; some electrolytic effect will at the same time occur, but the greater part of the charge will pass in a brilliant stream of light.

It remains now that we trace the passage of the voltaic current through the good conducting portion of its circuit; and it cannot be doubted that the process depends upon the same condition of particles as that which we described as preceding and accompanying the similar, but momentary, propagation of electricity from friction.

As an intermediate link between electrolytes and conductors, we are presented with a remarkable substance in *sulphuret of silver.* When placed in the circuit with a galvanometer, the needle indicates a feeble conducting power at ordinary temperatures; but on gently warming it the conducting power rises rapidly with the heat, till at length the galvanometer needle jumps into a fixed position, and the sulphuret, while still in the solid state, is found conducting like a metal. On allowing the heat to fall, the effects are reversed. While hot, the sulphuret conducts sufficiently well to afford a spark like a metal. Sulphuret of lead and some other sulphurets are also conductors of a similar kind.

This effect of heat is in direct contrast with its influence upon metallic bodies, the conducting power of which generally varies with their temperature, and is lower in some inverse ratio as the temperature is higher. If a fine wire of platinum of four or five inches in length be placed in a voltaic circuit, so that the electricity passing through it may heat the whole of it to redness, and the flame of a spirit-lamp be applied to any part of it so as to raise that part to whiteness, the rest of the wire will instantly become cooled below the point of visible ignition. For the converse of the experiment let the wire be suspended in a loop, and the lower part dipped into water or cooled by ice, and the other parts will immediately become much hotter, and from a red will rise to a white heat.

The effect of heat upon solid dielectrics is curiously contrasted with its influence upon the conducting power of metals; for if glass be heated it becomes a conductor, and incapable of insulating statical electricity.

The metals differ greatly from each other in the resistance which they offer to the passage of the current; and in general it may be stated that those which are the best conductors of heat are also the best conductors of electricity: it is therefore remarkable that charcoal, which is one of the worst conductors of heat, is an excellent conductor of electricity. It is not easy to determine the exact differences of the metals by experiments which are free from the intervention of disturbing causes.

Electrical Conduction.

Copper	100·	Platinum	16·4
Gold	93·6	Iron	15·8
Silver	73·6	Tin	15·5
Zinc	28·5	Lead	8·0

In experiments of this kind it is necessary to attend to the purity of the metals, for it has been ascertained, particularly by the experiments of Mr. Harris, that the conducting power of the alloys is very different from that of their component metals: an observation which greatly favours the view of conduction which refers it to an action of constituent particles.

In consequence of its good conducting power, a much greater length of silver wire of a given diameter will be maintained in a state of incandescence by a constant current, than of platinum or iron; but if a compound wire be made of alternate short lengths of silver and platinum, the latter will become red hot while the former

* Faraday.

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remains cold. The charge which passes freely along the silver meets with resistance enough in the platinum to produce ignition. If a platinum wire be passed through a vessel containing water, little of the current is diverted from its course, on account of the bad conducting power of the liquid for electricity of such low intensity; and the consequence is, that it may easily be made to boil by the heat evolved.

The law of conduction in metals, as we have already stated, has been determined, by very accurate experiments to be, that for the same metal, the power increases directly as the area of its section, and inversely as its length.

It is difficult, if not impossible, to establish anything like a rigorous comparison between the results of two processes so different as those by which conduction is carried on in liquids and solids; but M. Pouillet has determined that the same law is maintained for liquids contained in cylindrical tubes. He has also compared together the conducting power of different saline solutions so placed; the electrodes being formed of the metal the oxide of which was in solution; but of platinum for pure water. He found that 433 feet of platinum wire 0·006 inch in diameter, were equivalent to a column of saturated solution of sulphate of copper 3¼ feet in length, and 0·8 inch in diameter. This result makes the conductibility of the platinum two million and a half times greater than that of the solution.

Then taking the conducting power of a saturated solution of copper at 59°, as the standard of comparison, the power of other solutions he states to be as follows:—

Saturated Solution of Sulphate of Copper	1
Ditto diluted with 1 volume of Water	0·64
Ditto ditto 2 volumes „	0·44
Ditto ditto 4 volumes „	0·31
Saturated Solution of Sulphate of Zinc	0·417
Distilled Water	0·0025
Ditto with 1-20000th Nitric Acid	0·015

But although some notion may be formed from this comparison of the enormous difference between the resistance of a metal and of an electrolyte to the passage of a current, it must be quite clear, from our previous investigations, that nothing like accuracy can be attributed to it.—*Daniell's "Introduction to Chemical Philosophy."*

SUBMARINE TELEGRAPHY AND THE RETARDATION OF SIGNALS.

(Continued from p. 231.)

MR. WILDMAN WHITEHOUSE, as he states in his evidence, after spending night and day for three years working constantly in endeavouring to determine all the points that he could connected with deep-sea telegraphy, with respect to the laws of retardation and induction, and the most suitable form of instruments to be used, gives the following accounts of experience:—

"Chairman: What was the longest of the cables that you experimented upon previous to 1856?—160 miles was the length of the cable, as well as I remember, containing six wires.

"Was that cable coiled?—Yes, it was coiled in a tank at Messrs. Glass and Elliott's works, at Greenwich.

"What were the general results of those experiments?—It is difficult to give them in a few words. The first object was to ascertain, as nearly as I could, the law governing the retardation of the current at different distances, in order that I might discover the limits, if any, beyond which deep-sea telegraphy would cease to be practically attainable.

"Mr. Varley: I think you said that the cables were 160 miles in length upon which you experimented; did not you experiment upon a greater length than that?—At a later period I did, but not at that time.

"Was each wire 162 miles in length?—166 miles, I think, was the exact length.

"Chairman: Did you join the wires together?—Yes, I joined them together. The whole cable was 166 miles in length, and it contained six insulated conductors.

"Therefore you got six times that length?—Yes.

"What was the nature of your experiments?—The first was with regard to the velocity of the electric current under varying circumstances, trying the length of time that it occupied in travelling the 166 miles, then comparing it with the time required for two lengths of 166 miles, and three, four, five, and six lengths.

"Were the results satisfactory?—They were remarkable, certainly, and their invariable uniformity under like conditions was in the highest degree satisfactory. I experimented upon different forms of current, and upon different modes of using the same form. I mean the voltaic current as continuously employed by interruptions or repetitions of similar currents, or otherwise, alternately, a positive and a negative. Then I tried the magneto-electric current from the induction process, and from permanent magnets also. My object was to work out, as far as I could practically, the best form of instrument for use in submarine lines, the best form of current and the best mode of using it.

"What result did you come to?—I found that the voltaic current was at first very difficult to use with advantage in so long a length, rapidly. I found that its rate of transmission was slower than the magneto-electric current; I found, if used in repetition instead of alternating, that the charge of one current was blended with the charge of the next current, and that it came out almost as a continuous discharge at the other end of the whole length of the cable. I had, in some of the experiments, a second pendulum beating, giving the contact every second at one end of the circuit, which gave the voltaic current punctually as the pendulum beat; at the end of the whole distance, through the six wires joined up in a single length, it came out as a continuous discharge, without interruption. There was no variation in the current perceptible on the galvanometer receiving it, so that I then tried reversing, making the pendulum reverse the current at each beat one second positive and one second negative; I could then get distinct signals through the whole distance from that end, the negative current discharged the remains of the preceding positive current, and left the wire comparatively empty and ready for another current, so that you got a small portion of each current; a considerable portion of the current was consumed in discharging the preceding one; but a portion passed through the cable and was perceptible as a signal through the whole distance.

"Did you employ weak currents or strong currents?—The widest range which I had at my disposal.

"Mr. Varley: Can you state the limits that you started from?—I started from a single pair, the size of a sixpence, and I recorded signals through 1,000 miles with that distinctly, beating seconds alternately. I think the highest number of cells I had was 360, of the ordinary zinc and copper plates.

"Chairman: You also tried, you say, the magneto-electro currents?—Yes; I tried the voltaic current, beginning with the very weakest I could send. It required an exceedingly sensitive instrument and very perfect adjustment to show anything from a single pair. Then I gradually increased the number of pairs till I got to 360. I tried as far as I could to get at the ratio of the velocities of those different powers.

"With what general result was that experiment attended? Of which current was the velocity the greater?—Up to a certain point there seemed to be a question whether a sufficient amount of current arrived to actuate the instrument. It was rather a matter of the arrival of a portion of the current than the arrival of the maximum current, because beyond that no increase in amount of intensity appeared to augment the velocity at all. With about 18 or 20 cells I always found the slips recorded as high a velocity as with 360 cells; below this the observations were extremely critical and liable to instrumental error.

"You required a more delicate instrument?—I required a more delicate instrument. Although I could adjust the instrument to receive a signal from a single cell through 1,000 miles, yet I could not depend upon its accuracy to a minute fraction of a second for measurement of time.

"Mr. Saward: Were those signals received by relay?—Entirely, I have records of hundreds.

"Chairman: Will you be good enough to communicate those records?—Yes. In order to ensure accuracy I made the current on leaving the battery before entering the cable pass through a relay to make its mark, and on leaving the cable and entering the earth it passed through another relay, and made its mark; these marks were made by two styles on the same slip of paper.

"Was that in order to measure the speed of its travelling?—Yes, the recording mark was the electro-chemical decomposition.

"Mr. Varley: You have not stated the size of the wire nor what form the insulating material was?—It was an ordinary sixteen gauge wire, double covered with gutta percha of the usual thickness.

"Chairman: Were the wires joined together at the ends?—I had the command of the whole of the twelve ends; I could either make them go in circuit in the same direction or alternate them in opposite directions; I could test the effect of those different arrangements one against the other.

"Mr. Varley: What was about the speed that you obtained with the six times 166 miles in one continuous circuit with the battery power?—A retardation of about 2½ seconds.

"What was the relative speed of the different battery power used

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compared with the magneto current?—The magneto current was usually from 2½ to 3 times as rapid as the voltaic.

"If I understood you rightly you stated that you found, after you got up to 20 cells, that increasing the number of cells did not alter the speed of the current?—Not perceptibly.

"Did it accelerate it at all?—The 20 cells were sufficient to make the distant relay respond readily with moderately careful adjustment, and it required no subsequent adjustment at all. The experiments were perfectly satisfactory, and the velocity seemed to be the same from 20 cells to 360; it is true that I was working then with the sand battery, which has so much resistance; although you multiply the cells you do not increase the current in the same ratio.

"I should have anticipated with 300 cells you ought to have noticed a retardation of the speed?—I did not in any instance observe an increased retardation as the result of increased battery force. The slips are all marked with the memoranda taken at the time, showing exactly what was used.

"Do you think increasing the surface is objectionable?—I do not; but I think there may be a limit beyond which if you increase it you fail to attain any proportionate results.

"Supposing you increase the surface to an infinity of plates whose surface is a mile square; do you think you would do any harm by decreasing your speed if you had proper insulation?—I do not understand the meaning of the question.

"Supposing you increase the surface infinitely great, merely keeping the same number for tension, do you think you would cause retardation or weakening of the signals through the cable?—I do not think so; the general results of my experiments have gone in the opposite direction; whenever I have used induction coils with a larger secondary wire than before, I have got a more rapid current in every instance, when I have not sacrificed the adequate amount of intensity. You must have a certain amount of intensity to overcome the resistance of the circuit, and if you go beyond that amount of intensity you retard your current; in the first few miles you get a more rapid current, and in the last part of a long line it exhausts itself much more rapidly, the retardation being under those circumstances nearly as the square of the distance.

"Can you give any idea of the speed of transmission of the current through the gutta-percha covered subterranean wires of the Magnetic Company of 2,000 miles; I mean the length of time each current took; the speed of transmitting words?—I cannot tell you the speed of transmitting words; the induction coils were made to reverse the current alternately; the relay at the distant end was made to reverse the contact, it was merely enough to work a Morse instrument, so that every reversal of current gave us a dot.

"Mr. Saward: What was the form of signals used on that occasion?—Mere dots.

"How did you get your time?—It was counted by the minute; you could make so many dots in a minute. We got a large number of dots in a minute.

"Mr. Varley: Did you try different lengths?—Yes.

"Will you be good enough to give us those results?—We had only two evenings to try the experiments on those wires, and on neither evening had we all the time I could have wished. It was very late before we could get possession of the wires.

"You did not transmit any words through the length of 2,000 miles?—No; we did not attempt it; we had not arranged any code for transmitting. We used simply a reversing the key to work the induction coils.

"Mr. Saward: How many waves of electricity did you succeed in getting through per minute?—We got two, and two and a half a second; but I was not quite certain whether, during the whole of that experiment, the last 400 mile loop of the circuit was perfect. I do not think it was. I think there was during the most apparently successful part of the experiment from some cause, lateral contact, producing short circuit between the ends of that loop.

"Mr. Varley: That was two and a half reversals, which, if converted into dots, would have been one and a quarter dots?—If converted into dots in your usual way. If you require a positive and a negative to make a dot, it would have been a dot and a quarter; but on that occasion we made every reversal print a dot.

"Did you attempt dots and dashes?—In truth the instrument would not give dashes; it was merely to record the number of currents. It would not have been able to give dashes; it was not so arranged.

"Did you at a subsequent period try experiments over shorter lengths of subterranean or submarine wires?—I tried every length I could get of submarine wires down to four or five miles, as the Atlantic cable was made from time to time.

"Were not some experiments tried between Dublin and London with regard to printing?—I spoke on another occasion direct from London to Dublin.

"Did you transmit dots, letters, or words?—It was a dial instrument, and every reversal of the current threw it one step forward; we did not try to signal words. I had only about ten minutes or a quarter of an hour, when the time came to put the instrument in circuit.

"You merely sent reversals through?—We sent alternately currents received upon a relay to actuate a step-by-step dial instrument. The total length of circuit was 660 miles, all subterranean or submarine.

"At what speed did you get your reversals through it?—I can hardly tell you; I have no accurate account. I am quite sure that we got them through as quickly as one in a second; that was the longest length of subterranean or submarine wire at that time laid down.

"Do not you think there would be a great deal of difference between the simple transmission of reversals at equal periods, and the transmission of signals requiring unequal times; for instance, such as would be required for the transmission of dots, dashes, and spaces in the ordinary Morse alphabet?—There is the greatest difference the moment you begin to make your signals irregular, either in duration of time or strength of current; you introduce another element; you get your wire discharging itself unequally, and you are very apt indeed to lose a part of the signal; it requires very careful adjustment, and you are obliged to compensate, as it were, for the difference that time has introduced; you send into the wire currents equal in amount; you send a second current, and if you give them an unequal time to discharge themselves, you are obliged to introduce some system of compensation, in order that the currents may arrive at the other end in equal strength, without interfering with one another.

"Do you think the simple reversal of currents, and the formation of dots at the distant end would give any clue as to the speed of transmission that may be expected through a line of 2,000 miles, similar to the one you experimented upon?—Yes, practically the very best clue you can get, but you must make proper allowance. I marked that carefully as to what allowance we had to make, and I found where I could get through a certain number of dots, I could not get through more than a certain number of the usual concerted signals at varying intervals. Having found the number of equal reversals I could get through in equal time, I could deduce from that, in what time I could off the alphabet; there was about 12 per cent. difference; for instance, if I could get through 100 equal signals at equal times, I must reduce the speed of the instrument to 88, when I came to work the alphabet. I do not think there was a greater difference than that; but it was when the currents were compensated in the way I speak of, which requires extremely careful arrangement. In the Atlantic instruments there was arranged a system of compensation, which would take off from any given signal just so much as would allow for the lapse of time.

"Chairman: Did you find the results at which you arrived in your experiments upon those subterranean and submarine wires corroborated by the experiments which you subsequently made upon the Atlantic cable?—Most perfectly; we got 120 signals through from Newfoundland by these induction coils in a minute.

"Were those signals or words?—Simply reversals; we never got words through at that rate; those were the quickest signals that we ever had.

"Those were merely reversals?—Yes; that was their way of calling us; on some occasions we could see that they were trying their instruments, and it gave us the opportunity of adjusting ours, when they came to send words they did not attempt to send them as fast as that; I always explained to the clerks that it required a lower speed, and they knew exactly how much slower to work.

"Mr. Varley: When you say that you had 120 reversals a minute, do you mean 60 positive and 60 negative?—Yes, the highest speed of words we ever got actually was two words and three quarters per minute. I have an exact record of it, I think it is 41 words in 15 minutes, it was a message occupying 15 minutes, which came through at the rate of two words and three quarters a minute, with spaces between the letters, and double spaces between the words.

"The usual allowance of spaces?—Yes.

"Do you think that speed could be maintained throughout the day without interruption?—They could have worked faster than that—the currents came faster than that—with ease, for the instruments when they got 120 reversals in a minute could have sent four words easily by our arrangement with the antecedent compensation that I introduced. The mode adopted was, the induction coils gave us at every reversal of the primary current, of course, an equal amount of secondary current; but when they were to make a dash, this, occupy-

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ing time, required that there should be the compensation. I had so arranged that the key to the instrument making the dash produced the compensation exactly to the amount that was required; we could arrange or adjust it so that there should be either more or less compensation. I could see on the mirror galvanometer distinctly on one occasion that they had overdone their compensation in Newfoundland, and I sent them word.

"Was the over compensation by putting resistance into the circuit or cutting out some wire?—No, cutting out or neutralizing too much of the current. The truth is, if you send equal currents into an empty wire, or a wire which is charged with the previous current, they will travel at different speeds; the new current which is to charge the wire will, if it go into an empty wire, tell its tale more quickly, it would tread upon the heels of the previous signal in working too quickly, and wipe out a part of the previous signal. To prevent that, I had to send in a small fraction of the current preceding, and I had to make antecedent compensation in that way, because I found that they travelled at different velocities. These facts came out very curiously in some experiments I was making at Keyham, and they were borne out when the line was laid across the Atlantic. Currents of equal strength from the same apparatus will travel at different speeds, in accordance with the antecedent state of the wire, so that the mere varying lapse of time alters the rate of travelling of different signals.

(*To be continued.*)

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1854—London and North Western Railway.—

[Supplementary Report on the Extension of Telegraphic Communication. London: M'Corquodale and Co., Printers, 18, Cardington Street. Works, Newton.] 4to. 12 pages.

1851—Anonymous. ? Edwin Clark.

[The Electric Telegraph Company. New System of Train Signals. *Engineer's* Office, 448, West Strand, London. June, 1854.] Pam. 8vo., 10 pages.

1854 Cooke. W. Fothergill Esq.—

[The Electric Telegraph; was it invented by Professor Wheatstone? By William Fothergill Cooke, Esq. London: Printed for the Author, and sold by W. H. Smith and Son, 136 and 137, Strand.] Pamphlet.

1854—Wallace, W. Clay.—

[An Attempt to show that Light, Heat, Electricity, and Magnetism are Effects of the Law of Gravitation. By W. Clay Wallace, M.D. New York: D. Fanshaw, Printer, 35, Ann Street, corner of Nassau. 1854.] Pam, 8vo., 15 pages. Cuts.

1854—Clark, Edwin.—

[Letter to Captain Huish, as to proposed improvements in the Electric Telegraph System, for the service of the London and North Western Railway Company. By Edwin Clark, Engineer to the Electric Telegraph Company. March, 1854.]—Pam. 8vo, 30 pages. Cuts. London: Printed by G. Barclay, Castle Street, Leicester Square.

This Pamphlet contains the full description of the System of Train Signalling, generally termed the "Block System," first proposed by Mr. Edwin Clark, and now used on the North Western Railway.

1854—Tate, Thomas.—

[School Series, edited by the Rev. C. R. Gleig, M.A., Inspector-General of Military Schools. Electricity for the use of Beginners, in which the principles of the Science are familiarly explained and illustrated by numerous Experiments and Diagrams. By T. Tate, F.R.A.S., &c. London: Longman, Brown, Green, and Longmans. 1854].—12 mo, 100 pages. Cuts.

1854—Schellen, H.—

[Der Elektro-Magnetische Telegraph in den Nauptstadien Seinu entwickelung, und in seinu gegenwärligen Uusbildung, und Unwendung nebst einu kuszen Einlutung über die optische, und akustische Telegraphic und einem unchange über den gegenwärligen Betrieb du elektrischen Uhren. Für das Publikum, Freunde du Phisik angehende Telegraphen Beamten und Techniker beanbeitet. Von Dr. Schellen, Director der Real-und Povinzial-Gewerbe schule zu Münster, Tweite ganz umgearbeitete und den neuesten zuständen dis Telegraphen-Wefens angepaszle Husgabe. Mit 139 in dur Text, eingedrucklen Hobzschnitten, Braunschweig, Druck nud Perlay von. Friedrich Virweg un Sohn. 1854]. 8vo. 259 pages, Cuts and Plates.

1854—Clark, Edwin, C.E.—

[The Electric Telegraph Company, incorporated 1846. Letter to Captain Huish, as to proposed improvements in the Electric Telegraph System. For the Service of the London and North Western Railway Company, by Edwin Clarke E.E., Engineer to the Electric Telegraph Company. March, 1854]. Pamphlet, 8vo.

1854—Tate, Thomas.

[Gleig's School Series. On Magnetism, Voltaic Electricity, and Electro-Dynamics: For the use of Beginners; in which the principles of the sciences are familiarly explained and illustrated by numerous experiments and diagrams. By T. Tate, F.R.A.S., late Mathematical Professor in the National Society's Training College, Battersea, &c., &c. London: Longman, Brown, Green, and Longmans. 1854.] 12mo., woodcuts. 1s.

1854—Rutter, J. O. N., F.R.A.S.

[Human Electricity; the means of its Development: Illustrated by Experiments; with Additional Notes. By J. O. N. Rutter, F.R.A.S. London: John. W. Parker and Son, West Strand, 1854.] Small 8vo.

1854—

[General Regulations for the working of the Electric Telegraph on the Shrewsbury and Hereford Railway; with Special Instructions for Signalling of Trains on the said line. Printed by J. O. Stamford, High Street, Shrewsbury. MDCCCLIV.] Pamphlet. Small 8vo., 18 pages.

1854—Turnbull, Laurence, and Mc Rea, William C.

[Railroad Accidents, and the means by which they may be prevented by the use of the Electro-Magnetic Safety apparatus. To which the attention of the travelling public, Presidents and Directors of the various Railroads throughout the United States is respectfully requested. By Laurence Turnbull, M.D., Author of Lectures on Electro-Magnetic Telegraph, and W. C. Mc Rea Telegraphic Engineer. Philadelphia: Parry and McMillan. 1854.] 8vo.

1854—Adley, Charles, C.E.

[Anglo-Indian Telegraphs, or Communication with London in Six Hours. By Charles Adley, C.E., East Indian Railway. Author of the Premium Essay on the History, Theory, and Practice of Telegraphs, &c. Calcutta; Printed by Sanders, Cones and Co, No. 65, Cossitollah. 1854.] Pamphlet.

? 1855.—? The Swiss Government.

[III. Instruction pour les Télégraphistes de la Suisse, basée sur l'emploi du systeme Steinheil pour l' E'tablissement du réseau et des stations, suivi d'une description complète de tous les appareils, de leur disposition, de leur rectification et de leur maniement, et accompagnée d'une carte du reseau télégraphique Suisse.]—8vo 128 pages, numerous cuts and plates. No publisher's name or date. It appears to be a third part.

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1855—

[The Electric and International Telegraph Company's Map of the Telegraph Linesin Europe, 1856. Published under the authority of the Electric Telegraph Company, by Day and Son, Lithographers to the Queen.] August 9th, 1855.

1856—Airy (G. B.)

[On the difference of Longitude between the Observatories of Brussels and Greenwich, as determined by Galvanic Signals. By G. B. Airy Esq., Astronomer Royal. London: Printed by George Barclay, Castle Street, Leicester Square. 1855] 4 to 25 pages.

From the Memoirs of the Royal Astronomical Society, Vol. XXIV.

1855—Becquerel and Becquerel Edmond.

[Traité d' Electricité et de Magnétisme, et des applications de ces sciences à la chimie, à la physiologie, et aux arts. Par M. M. Becquerel, de l'Académie des Sciences, de l'Institut de France, &c., et Edmond Becquerel, Professeur au Conservatoire Imperial des Arts et métiers. Paris: Librairie de Firmin Didot Frères, Imprimeurs, de l'Institut Rue Jacob, 56, 1855.]—8, vo 3 vols. Numerous cuts and plates.

Vol I, 449 pages; Vol II, 467 pages; Vol III, 406 pages.

1855.—Shaffner, Col. T. P.

[Shaffner's Telegraph Companion, devoted to the Science and Art of the Morse American Telegraph, 1854-5. A Periodical Publication, issued monthly, and extending over the years 1854-5. Published in New York.] 8vo., 400 pages.

1855.—Newall, R. S. & Co.

[Application of the Theory of the Conduction of Electricity through Solids.in estimating the Dimensions of Submarine Telegraph Wires required for Long Distances. Compiled from the researches of Michael Faraday, D.C.L., F.R.S. &c., Werner Siemens, of Berlin, William Thompson, A. M., F.R.S. &c. Printed for private circulation. By R. S. Newall & Co. August, 1855] Pam. 8vo., 16 pages.

1855—Ogam, Alfred.—

[Railway Collisions Prevented. By Alfred Ogam, London: G.J. Pope, 12, Church Street, Hackney, 1855.] Pamphlet 24 Pages, Illustrated.

1855—Sidney, Edwin.

[Electricity, its Phenomena, Laws, and Results. By the Rev. Edwin Sidney, A.M. A New Edition. London: the Religious Tract Society's Depositories, 56, Paternoster Row, 65, St. Paul's Churchyard, and 164, Piccadilly, and sold by the Booksellers.] 24mo. Woodcuts.

No date on Title; but Preface to Second Edition is dated Jan. 18, 1855.

1855—Noad, Henry M., F.C.S.

[A Manual of Electricity, including Galvanism, Magnetism, Diamagnetism, Electro-Dynamics, Magneto-Electricity, and the Electric. By Henry M. Noad, Ph.D., F.C.S., Lecturer on Chemistry at St. George's Hospital, &c., &c. Fourth Edition, entirely rewritten, Part 1, Electricity and Galvanism. London: George Knight and Co., Foster Lane. 1855.] 8vo.

1855—Grove, W. R.

[The Correlation of Physical Forces. By W. R. Grove, Q.C., M.A., F.R.S., &c. Third Edition. London: Brown, Green, and Longmans. 1855.] 8vo., 229 pages.

Pages 81 to 111 on Electricity. Pages 151 to 163 on Magnetism.

1855—Davis.

[Davis's Manual of Magnetism, including Galvanism, Magnetism, Electro-Magnetism, Electro-Dynamics, Magneto-Electricity, and Thermo-Electricity. With 180 original Illustrations. Seventh Edition. Boston: published by Palmer and Hall, successors to Daniel Davis, Jun., Magnetical and Telegraphic Instrument Makers, 526, Washington Street. 1855.] Demy 8vo., 322 pages. Numerous plates.

1855—Bois, Victor.

[La Télégraphie Electrique. Par Victor Bois, Ingénieur Civil. Deuxième Edition. Paris: Libraire de L. Hachette et Co., Rue Pierre Sarrasin, No. 14. 1855.] 12mo., 126 pages. Price one franc.

1855—Miege, B. and Ungerer, T. R.

[Vade mecum pratique de Télégraphie Electrique a l'usage des employés du Télégraphe. Premiere Partie. Cours Elementaire proposé a l'administration centrale des lignes Télégraphiques. Par B. Miège. Deuxième Partie. Etudes pratiques sue le systeme et l'appareil Morse. Par T. R. Ungérer. Paris: Librairie Scientifique Industrielle De F. L. Mathias, Quai Malaquais, 15. 1855.] 12 mo., 66 pages, plates and cuts.

1855—Faraday, Michael.

[Experimental Researches in Electricity. By Michael Faraday, D.C.L., F.R.S., &c. Reprinted from the Philosophical Transactions of 1846-52, with other Electrical Papers from the Proceedings of the Royal Institution and Philosophical Magazine. Vol. III. London: Richard Taylor and William Francis, Printers and Publishers to the University of London, Red Lion Court, Fleet Street. 1855.] 8vo. Plates and woodcuts.

1855—Lardner, Dionysius, D.C.L.

[The Electric Telegraph Popularised, with one hundred Illustrations. By Dionysius Lardner, D.C.L. Formerly Professor of Natural Philosophy and Astronomy in University College, London. From the "Museum of Science and Art." London: Walton and Maberly, Upper Gower Street, and Ivy Lane, Paternoster Row. 1855.] Demy 8vo. Woodcuts.

ON THE MOST RECENT SPECTRUM DISCOVERIES.

BY PROFESSOR W. ALLEN MILLER, F.R.S.

(*Lecture read at the Royal Institution, March* 6.)

The subject of the lecture, the learned Professor said, was, perhaps, the most extensive and fascinating which presented itself to scientific men. On the present occasion he intended to limit himself to but a few of the interesting discoveries made in this great field of research, and hoped he should not be considered egotistical if he referred to his own experiments. Among the rays emitted by the sun there were three kinds, interesting as endowed with special action—those which conveyed heat, light and chemical action. With heat he should have but little to do on this occasion; about light he had something to say; but he was now principally concerned with the rays which manifested themselves by producing chemical action. It was well known that transparent substances did not transmit all these rays with equal facility. Glass was only imperfectly transparent to the chemically active rays, which were found in the most refrangible rays of the spectrum, heat rays being in the least refrangible portion, and light occupying the middle place. It had been found that rock crystal was one of the few substances which perfectly transmitted rays, those highly refrangible, which glass absorbs.

The Professor then showed that some kinds of light were without chemical action, the light from a mixed air-gas flame possessing scarcely any, while that from an ordinary gas flame did possess a little. The oxy-hydrogen flame, while attended with intense heat, was endowed with very little chemical action. A prepared collodion plate exposed to this light for twenty seconds gave a very faint picture. But when the flame was thrown on lime, although the temperature was lower, the light had sufficient chemical activity to produce a strong picture, on a similarly prepared plate, exposed for the same time. In the case of the chemically acting rays the intensity, number and position of the lines on the spectrum had been found to vary with the source of light. The most remarkable illustration of this was the different spectra produced by the electric spark of an induction coil between poles of different metals and projected upon a photographic plate.

The spectrum produced by the spark from silver poles, for example, was found to be three times the length of the whole of the solar spectrum transmitted by quartz. In order to obtain views of this invisible spectrum

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it was necessary to transmit the rays through a medium more transparent to chemical rays than glass, which it had been said, was opaque to the higher rays of this kind, and various experiments had been made to ascertain what substance allowed them to pass most freely. The results were shown in the following table of the—

Photographic Transparency of Solids.

Rock crystal	74	Sulphate of magnesia	62
Ice...	74	Borax	62
Fluor spar	74	Bromide of potassium	48
Topaz	65	Thin glass	20
Rock salt	63	Mica	18
Iceland spar	63	Iodide of potassium ...	18
Diamond	62	Nitrate of potash ...	16

The above numbers being founded upon an arbitrary division of the spectrum.

The photographic transparency of liquids differed still more, as would be seen from the following diagram :—

Photographic Transparency of Liquids.

Water	74	Wood spirit	20
Alcohol	63	Acetic acid	16
Chloroform	26	Oil of Turpentine ...	8
Benzole...	21	Bisulphide of Carbon	6

Various gases were also found to interfere with the transmissibility of these rays, as exhibited in the table of the—

Photographic Transparency of Gases.

Hydrogen	74	Benzole vapour	35
Nitrogen	74	Hydrochloric acid ...	55
Oxygen	74	Hydrobromic acid ...	23
Carbonic acid	74	Hydriodic acid	15
Olefiant gas	66	Sulphurous acid	14
Marsh gas	63	Sulphuretted hydrogen	14
Coal gas	87		

The diamond and rock crystal allow the chemical rays to pass freely, but other substances, in which no difference of transparency can be discovered by the eye, considerably affect the transmission of these rays. Chloride of potassium allowed them to pass less freely; and nitrate of potash, and nitrates generally, offered still more obstruction. It was the same with fluids, and also with gases, as would be seen by a reference to the diagrams. It was remarkable, too, that solid bodies when dissolved or melted maintained exactly the same power as when in the solid state. The same was the case when they were converted into vapour, which showed that this power was part of the nature of the substance.

The lecturer then described the phenomenon of fluorescence, and showed that the chemical rays of the spectrum corresponded with the rays of fluorescence by taking a photograph in that part of the spectrum which, though otherwise invisible on the screen, lighted up a solution of æsculine. He then showed that all metals give characteristic photographic spectra, some of them bearing a strong family resemblance to each other, as in the cases of iron cobalt and nickel, the last metal giving one of the longest spectra observed, and which extended to 190° of the scale. Arsenic, antimony, and tin showed as great differences in the invisible as visible part of the spectrum. The most interesting of the metals to study in this respect was magesium, which opened a wide field for investigation. There were certain points of resemblance between the spectrum of magnesium and that of the sun, which lead to the supposition that this metal existed in the solar atmospheres. The comparison of the spectrum of magnesium with that of the sun led also to some important considerations as to the temperature of the sun. It was known that the higher the temperature the more refrangible were the rays of light emitted by a body. We have no conception of the temperature of the electric spark. The heat of the strongest wind furnace was estimated at 4,500° F., and that of the oxy-hydrogen jet was supposed not to exceed 15,000° F., yet with neither of these could the same effects be produced as with the electric spark. The lines of the photographic spectrum of magnesium were not seen in photographs of the solar spectrum, and yet there was no doubt that this metal was present in the solar atmosphere. Kirchoff had discovered that solids when heated give a continuous spectrum, but that bodies in the form of gas give rays of definite and limited refrangibility, each substance emitting light of definite property. He had also noticed that light from a luminous mass, by passing through ignited vapour which, *per se*, would give bright lines in the spectrum, became furrowed out in dark bands occupying exactly the same position in the spectrum as the bright lines. Now, ignited magnesium vapour emitted green rays which were absolutely identical with the group of fixed lines *b* in the solar spectrum, and it was therefore certain that magnesium was a constituent of the sun. It was, moreover, probable that the heat of the sun was inferior to that of the electric spark, inasmuch as it was insufficient to bring out the highly refrangible lines observed in photographs of the magnesium spectrum.

There were thirteen bodies known on earth which these researches lead us to suppose existed in the solar atmosphere. Nor are they limited merely to the sun. Fraunhöfer had examined the spectra of several stars, and found that although they presented no similarity to that of the sun, nor to each other, yet that some general relationship between them was observable.

Mr. Huggins and the lecturer had recently been investigating this subject, and had obtained very perfect maps of the visible spectra of several stars. They had also obtained a photograph of the spectrum (which was exhibited) of Sirius. This star is 130,000,000,000 of miles distant, and the light which produced the photograph must have left it twenty-one years ago.

A photograph of the spectrum of Capella, which is three times further distant than Sirius, had also been obtained, the light to produce which, the lecturer said, must have left that star when the oldest in the room was a little boy. Professor Miller concluded an eloquent address, of which the above is a mere outline, by remarking how much these wonderful facts enlarged our ideas of the power of the great Author of the Universe, whose will "creates, sustains, and animates the whole."

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	... 1s. 11d. to 2s.	per lb.
Second „	... 1s 6d. to 1s. 10d.	„
Third Negro	... 1s. 1d. to 1s. 2d.	„
Java	... 1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine none worth	... 2s. 8d. and above.	
Genuine mixed	... 1s. 9d. to 2s.	per lb.
Reboiled good	... 1s. 5d. to 1s. 8d.	„
Ordinary ditto	... 1s. 0d.	„

March 25, 1863.

Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	65 to 69	
Stock	Electric Telegraph . .	100	99 to 102	
5	London District Telegraph .	all	2 to 2½	2¼
10	Mediterranean Extension Tel.	all	3 to 4	
1	Submarine Telegraph, scrip. .	all	½ to ¾	
2	Telegraph to India . .	1	⅞ to ⅝ dis.	¼
5	United Kingdom Telegraph .	3	¼ dis. to ¼ pm.	

ATLANTIC TELEGRAPH COMPANY.

The sixth ordinary annual meeting of the shareholders in the Atlantic Telegraph Company was held at the London Tavern, on Thursday the 19th inst., for the purpose of receiving a report and balance-sheet from the directors, and for transacting the ordinary business of the company. Also to rescind the resolution passed at the extraordinary general meeting of the shareholders on the 8th of June, 1859, whereby the number of directors was thenceforward limited to twelve, and to substitute in place thereof a resolution extending that body to eighteen. The Right Hon. James Stuart Wortley occupied the chair.

Mr. George Saward, the secretary, having read the notice convening the meeting, read the report of the directors, an abstract of which has already been published.

The Chairman, in moving the adoption of the report, said no doubt the shareholders would be anxious to know what had been done since their last meeting in December, and what were the prospects of the company, and to those subjects he should confine himself, with the exception of two or three points of explanation, which he considered ought to be afforded to the shareholders. Since the last meeting they had been subjected to a series of covert attacks from some enemy, but that was to be expected, for it was always the case, whether it was a company, or a private individual, that had a great affair in hand. That hostile feeling had emanated from sources which were perhaps interested, either from being in a species of rivalry with them, or from feelings of jealousy in not being able to join in their proceedings, or from inventors who had not had their inventions tested, as they ought to be, before being adopted by a company like theirs, and which they were, therefore, not in a position to accept. They had also been attacked for holding out inducements to the public by offering advantages which it was alleged they did not possess; and also, that they were setting out on this fresh enterprise with no new means, with no

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new information, with no new inventions. Now, none of those surmises were correct. They would see by the accounts that the company was not in debt, and free from any liabilities which could affect them, besides which they had their privileges intact. Some had spoken against their exclusive rights, which they termed the company's monopoly, and others had called the directors rash and foolish for binding themselves in contracts for doing certain works. All those were incorrect. They had held out to the public that they had exclusive rights, and that they had the advantage of a Government guarantee and subsidy for the transmission of their messages to and from America. The facts were, that they had entered into no engagements with any other company except the New York and Newfoundland Company, which had originally obtained the exclusive privilege of landing the cable at Prince Edward's Island, Newfoundland, and the coast of Labrador, from whom they, in the first instance, obtained possession of their charter, in order to bring their cable from Ireland to Newfoundland. With regard to the contractors, they had entered into no positive contract with them, and if there was anybody who would do the work on more advantageous terms for the company than they were willing to do it, they would retire, and leave it in their hands to execute it. Those who had referred to their right had spoken of them as doubtful, but he would refer to the letter from E. M. Archbold, Esq., the late attorney-general for Newfoundland, at present Her Majesty's consul at New York, and another letter from the Hon. G. S. Hogsett, the attorney-general at Newfoundland, both of which clearly proved that the concession made to the New York and Newfoundland Company of the exclusive right to land telegraph cables on the coast of any island or place within the jurisdiction of the Government of Newfoundland was within the power of the Newfoundland Government. The extent of the territory not only comprised the island of Newfoundland but the whole of the coast of Labrador. It had also been said that they had parted with their privilege to the Government. They had done so conditionally to a certain extent. They had agreed, when the cable was complete and the guarantee came into operation, to surrender to the Government the right which they possessed under their charter of allowing other cables to be laid on that coast, but that consent also required the consent of the New York and Newfoundland Company. He had no fear that the Government would do anything that would tend to diminish their profits, because it would involve a probability of falling back upon the guarantee. He might also mention that should the cable get out of order and the guarantee lapse, the right of allowing cables to land on their shores would revert back to the Company. They had had an agreement with the Government for a subsidy of £14,000 a year for transmitting their messages to America, and a similar amount from the American Government for doing their business; but since the last meeting they had induced the English Government to increase the amount of their subsidy to £20,000 a year on the successful laying of the new cable. The right honourable gentleman then entered into a long explanation of the respective qualities of gutta percha and india rubber, and the reports that had been made upon the tests to which they had been subjected, and while admitting the superiority of india rubber over gutta percha in some localities, claiming a superiority of pure gutta percha over india rubber in other localities. They had, however, he said, been so careful that they had not as yet decided of what material the cable should be made or the exact form of construction. With regard to the capital, although they had taken powers to raise £600,000, he believed that £300,000 would be ample for all their purposes. They had already got £208,000 subscribed, and he had no doubt in the course of a month or two they would have the remainder. He had been to Bradford, Liverpool, Manchester, and Sheffield, and had received support from merchants of the highest standing, and he had also received information from New York, that the merchants there would subscribe liberally towards it. After entering into some personal explanations regarding what he had said about the telegraph between Toulon and Majorca, he concluded by urging the shareholders to induce their friends to take up the balance of the shares. He then formally moved the adoption of the report.

Mr. C. M. Lampson, the deputy chairman, seconded the motion, and it was adopted unanimously.

The following directors, who retire by rotation, were re-elected:—The right. hon. the Chairman, Mr. C. M. Lampson, Mr. S. Gurney, M. P., and Captain A. T. Hamilton.

The Chairman moved a resolution, rescinding a resolution passed on the 8th of June, 1859, which reduced the number of directors from 18 to 12.

Mr. Lampson seconded the motion, which was also carried.

The Chairman then said that the board had nominated three gentlemen as directors in accordance with the deed of settlement, and he was quite sure the shareholders would be satisfied that so wise a choice had been made. The names of those gentlemen were Mr. E. Cropper, Sir W. Brown, and Sir Samuel Cunard. He then proposed the election of George Parker Bidder, Esq.

This was seconded and carried unanimously. The honorary directors retiring by rotation—viz., Mr. A. A. Low (of New York), the Hon. G. E. Cartier (of Quebec), and the Hon. John Robinson (of St John's, New Brunswick) were then re-elected, as was also Mr. W. H. Blackburn the auditor.

A cordial vote of thanks was given to the Chairman for his indefatigable conduct, and the meeting separated.

The Patriarch Reid's Forecasting of the Extensive Application and Success of Submarine Telegraphy.

On Wednesday a number of scientific gentlemen met at the new Railway Station, Hull. for the purpose of witnessing the testings of a subaqueous telegraph, which the Electric Telegraph Company have just laid down between the new Railway Station and the Company's Subscription Rooms in Bowl Alley Lane. It was a case of considerable interest to those connected in any way with Submarine Telegraphy on account of the difficulty which presented itself in passing under the docks, where the depth of water varies from 18 to 24 feet; water, damp, and moisture being, as is well known, the most formidable enemies which the Electric Telegraph has to contend with—catching up as they do the electric current, and dispersing it in all directions. The experiment was conducted by Mr. Reid of London, one of the Company's engineers, and we are happy to say with perfect success. There were four copper wires insulated. Each wire was tested singly with a galvanic battery of 72 pairs of plates connected with a very delicate galvanometer; and the insulation between each wire, and also between the wires and the earth, was so perfect as not to produce the least perceptible oscillation in the magnetic needle of the instrument.

We hail this as a great step in electric telegraphy, and with the more pleasure, that there has been of late a sensible pause in its progress. We still entertain a strong hope that the day is not far distant when the metropolis will be telegraphically connected with all the principal cities and towns, not only of our own country, but of Europe—when every movement tending to the promotion of trade and commerce, or to the diffusion of peace and good will among mankind, will be simultaneously felt through the whole circle of European civilization.—*Extracted from the "Mechanics' Magazine," Jan.* 13, 1849.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—The Government Committee in their Report on Submarine Telegraphy spoke so highly of the qualities of india rubber as an insulator for telegraph cables that it seemed not unreasonable to expect that the Government would, on the first occasion of their requiring a submarine cable, so far follow out the recommendations of the Committee as to employ this material as their insulator. This, however, has not been the case; the Persian Gulf cable, like all former lines, is being manufactured of gutta percha, and your columns bear ample evidence of the disappointment which this decision has occasioned, to those interested in the former material, in the shape of weekly criticisms on the design of that cable.

It is not, however, I think, sufficiently borne in mind that the Committee in their labours confined their attention solely to the behaviour of the materials submitted to them, on the small scale, and it did not become necessary for them to decide whether these materials could be obtained in sufficient time and quantity for practical requirements nor what were the prospects of their success and permanency if employed on the large scale. The Government had, however, to give due weight to these points among others, and had also the advantage of experiences which did not exist at the time the Committee conducted their inquiries; one of which I will now give you.

In 1860 the Red Sea Telegraph Company submerged a length of cable insulated with india rubber at Kurrachee, in India, for the purpose of testing its durability. This cable was about 2,000 yards long; it was covered with hemp and with thick iron wires in the usual way, and was tested by Mr. Fleeming Jenkin, whose results are given at page 144 of the "Government Report."

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Being at Kurrachee in the spring of last year I raised and examined the greater portion of this cable, and brought portions of it to this country. When tested from land it was found defective, and, when afterwards cut at sea, each half was in the same condition. Further examination showed that the defect was general, and every fathom examined proved more or less faulty. The india rubber had lost its colour and insulating properties, and had evidently undergone the peculiar change or hydration which is well known to occur in this material, and which is fully described in my Report to the Submarine Telegraph Committee, page 330. The manufacturers who have seen portions of this cable believe that they can explain the causes of the failure; but, whatever they may be, it is evident that if such a cable had been laid on the large scale it would have proved absolutely worthless.

On the other hand it was found that the gutta percha of the Red Sea cable had not been in any way affected, either by the climate, by insects, or by the action of the sea water, and was, as far as it was examined, as perfect, both electrically and mechanically, as when it left the manufactory.

At the same time, although this experience justifies the observance of great caution in the introduction of india rubber, I am far from considering it conclusive. I believe that in some of its forms, especially in combination with sulphur, it will prove the most suitable of all materials for many localities, and I think it almost certain that before long we shall see it in extensive and successful use. Two things are, however, yet requisite for this end; one is the experience of a practical test of its efficiency, such as that obtained at Kurrachee; the other is an assurance that the manufacturers have had sufficient experience in its manipulation to give it all the perfection of which the material is capable.—I am, sir, your obedient servant,

Latimer Clark.

To the Editor of The Electrician.

Sir,—With all due deference to Mr. Forde, I beg to repeat that I have seen samples of gutta-percha covered wire eaten through and through by marine animalculæ, and I submit that for all *practical* purposes the memorandum left by my late cousin Lionel, as published by Mr. Forde, substantiates my statement.

If, after a few months' submersion, marine insects devour a short length of gutta-percha covered wire "thickly into small holes, three or four times the size of pins' heads" (the largest being an eighth of an inch in diameter), "and the 32nd of an inch deep,"—in fact through and through the second or outer layer; it would be a mere matter of time for them to perforate the inner coating also.

So long as any of the outer layer of gutta percha remained unconsumed upon the particular specimen now in question, Chatterton's compound may have proved less palatable to their tastes, and may therefore "*appear* to have been uninjured;" but that a thin film of such compound would have prevented a later attack, requires a greater amount of credulity than my experience warrants.—I am, sir, yours faithfully,

F. N. Gisborne.

P.S.—At a late meeting of the Atlantic Telegraph Company, the Right Honourable Stuart Wortley, Chairman, is reported to have said, "A great deal has been said as to the relative merits of india rubber and gutta percha, but it was found that *the pure sort of the latter* (gutta percha) was nearly equal to the former (india rubber) for insulating purposes."

Further comment is unnecessary. F.N.G.

To the Editor of The Electrician.

Sir,—It is not usual when discussing an open question, to throw assertions broadcast in the hope that such would be accepted as arguments, and, with all due regard to Mr. Laming's feelings, I must submit that, upon finding that I had shaken the very basis of his theory, it would have been "ingenuous" on his part had he, as he had promised to do, removed my objections by pointing out their fallacy rather than by galloping round them mounted on a repetition of the very grievance itself, and then dubbing my objections as "sophistry." If, Mr. Editor, objectors can be so readily removed, I can easily supply you with any number of theories, each of which shall be warranted to do the maximum of work at a minimum cost.

But to return to the question as it stands. I say that it is impossible, practically, with the same "source of power," either to force equal quantities of electricity or water through long depths of wire or pipes, as through short lengths of equal calibre.

Secondly (following Mr. Laming's analogy), that in accordance with the principles of hydraulics as given by Hutton (an authority whose "sophistries" must be exposed before they are condemned), I urge that the mere contraction of the sectional area of a conducting wire in any part of the circuit would simply cause an increase of velocity in the "fluid" while passing the contracted portion of the wire (or pipe) and not as stated by Mr. Laming, reduce the whole circuit to one of equal dimensions with the contracted part throughout its length.

I do not complain of any want of a knowledge of etymology on the part of Mr. Laming, nor am I aware of having uttered one word disrespectful in the slightest degree to the gentlemen of the profession to which he belongs; but I must enter my protest, weak though it be, against any person adopting words of well-known signification, adapting them to their own specialities, and then misjudging others who happen to read them as conveying their ordinary meaning. There was a time when the expression "to let" had the directly opposite signification which it now implies, and perhaps the "conductivity of my system" with Mr. Laming may mean "retardation," or even total abstinence from all conducting power, &c., &c., but your readers are obliged to comprehend your contributors' notions from what they say and not from what they mean.

In conclusion, I am not unconcious that the confounding of addition with multiplication is no less confusion, even if the confounder be not a mathematician: my object in referring to the subject was merely to show the folly of an exact reasoner adopting such a simile to gain a point.

Relay Magnet.

THE MECHANICAL THEORY OF THE LAYING OF CABLES.

[We have received from M. H. Blerzy, member of the *Comité de Redaction* of the *Annales Télégraphiques*, the following communication relative to Captain Selwyn's contribution, inserted at p. 205 of the present volume.]

A M. le Redacteur en Chef de l'Electrician.

Monsieur,—Je viens de lire dans le numéro de l'Electrician du 6 Courant, des remarques du Captain Selwyn à l'occasion d'un article que j'ai publié dans les Annales télégraphiques sur l'immersion des cables sous-marins. Les idées que j'ai émises me paraissent avoir été mal traduites eu Anglais par mon contradicteur, je vous prie de vouloir bien inserer ces quelques lignes de rectification.

Le Captaine Selwyn se livre à une discussion tres intéressante pour démontrer que la courbe affectée par le cable pendant la pose n'est pas toujours une chainette. S'il avait lu entièrement mon article, il aurait vu que je fais les mêmes réserves que lui, que je n'emploie le mot chainette que pour simplifier er préciser le discours, et que le raisonnement qui justifie mes conclusions ne se base sur aucune des propriètés de la chainette.

Quant á la manière dout M. Selwyn interprète ces conclusions en les fesant passer du français en anglais, elle diffère tellement des idées que j'ai voulu exprimer que je ne saurais répondre en peu de mots á ses objections. D'ailleurs je craindrais de mal comprendre, à mon tour ses raisonnements; car je lis dans ses Remarques:—"The increased tension is always as the depth, not as the length of the curve. . . . . If there were 20 miles of cable out astern of the ship, the weight would be, if in two miles of water, no more than 2 miles weight," or, ceci traduit textuellement en français une parait formuler une grosse hérésie.

Je crois que M. Selwyn s'est laissé dominer, eu écrivant ces lignes, par des considerations purement pratiques, l'influence des courants, du tangage, &c., que j'ai du negliger dous un travail théorique et qu'il serait aisé, si je ne me trompe, de sonmettre á la théorie eu les transformant en variations de la tension, du frein, ou de la profondeur. En ce qui concerne la machine inventée par lui pour l'immersion des cables, je me garderai bien de la discuter, car je ne la connais pas. J'accepte voluntiers l'offre qu'il me fait de m'envoyer des explications detaillées sur son système. Je vois qu'il est fréquemment question en Angleterre des "floating cylinders for laying submarine cables;" en France, à ma counaissance, rien n'a été essaye, ni propose, ni meme publie, sur ce sujet. Je serais heureux de combler cette lacune. Les *Annales Télégraphiques* accueillent toujours avec plaisir les communications de correspondants étrangers, et s'empressent de porter à la connaissance du public les renseignements de toute nature sur les questions si diverses er si interessantes de la télégraphie sous marine.—Veuillez agréer, Monsieur, &c.,

Blerzy.

Troyes, Le 23 Mars, 1863.

To Correspondents.

I. Cook.—The voltaic arrangements you mention, consisting of plates of the same metal immersed in different solutions, were first investigated by Sir Humphrey Davy, and have since, at various intervals, received attention. We do not anticipate that any of them can be rendered of practical utility, as, in the first place, they are very deficient in electro-motive force, and moreover do not offer any corresponding advantage in point of economy. The sulphate of iron might be found useful as a negative exciting fluid, by reason of its affinity for atmospheric oxygen and the reduction by hydrogen of the per-salt formed by its combination with this gas. But copper or platinum, whatever may be used for the positive, would obviously be a better negative than iron, and would allow of the addition of sulphuric acid to the fluid for the purpose of improving its conductivity.

T.R.O.—We shall be glad to hear whether your suggestion for a "contact-breaker" is found to answer practically. The same principle might perhaps be usefully applied in other cases. We have verified the phenomenon on which the suggestion is based.

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The Electrician.

Vol. III. No. 74.—April 2, 1863.

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HOLLOW AND SOLID CORES FOR ELECTRO-MAGNETS.

Under many circumstances the weight of an electro-magnet or magneto-electric coil, especially when of large size, may constitute a serious objection to its use in various mechanical appliances. It has been found, for instance, that in some magneto-electric telegraph apparatus the momentum acquired by the rotating coils, with their cores of soft iron, has rendered impossible the adoption of certain improvements which, under other conditions, might have been advantageously applied. The following experiments of M. Th. Du Moncel, are therefore of some practical interest.

An electro-magnet was constructed in which the following pieces of soft iron might be substituted for each other, or used in combination, as the core, viz. :—

1st. A solid cylinder, 7 *centimètres* in length, 14 *millimètres* in diameter.

2nd. A hollow cylinder or tube of the same dimension externally as the preceding and 2 *millimètres* in thickness.

3rd. A solid cylinder of the same length as the first and 9½ *millimètres* in diameter.

With a battery of 70 small elements of Daniell, the following results were obtained :—

1st. With the cylinder No. 1 the attractive force was,

At the distance of 1 *millimètre* 50 *grammes*,
" " 2 " 20 "
" " 3 " 9 "

2nd. With the hollow cylinder,

At the distance of 1 *millimètre* 31 *grammes*,
" " 2 " 12 "
" " 3 " 5 "

3rd. With the smaller cylinder placed in the interior of the preceding,

At the distance of 1 *millimètre* 46 *grammes*,
" " 2 " 17 "
" " 3 " 7 "

It appears from these experiments that electro-magnets constructed by a hollow core of soft iron are considerably weaker than those in which the core is solid; but that, as might have been anticipated, the power of the former is increased by placing a solid bar of metal in the interior of the cylindrical tube. It remains to be shown whether the advantage of the solid core was not principally or wholly due to the extension of the polar surface. A disc of metal of 5 *millimètres* only in thickness was therefore cut from the smaller cylinder, and arrangements were made to place this disc in the interior of the hollow cylinder either on a level with its polar surface (or extremity) or at certain distances below this surface. With a battery somewhat weaker than that first employed, the results were as follows :—

1st. With the large solid cylinder the attractive power was,

At a distance of 1 *millimètre* 38 *grammes*.
" " 2 " 13 "
" " 3 " 4 "

2nd. With the tube of soft iron,

At a distance of 1 *millimètre* 25 *grammes*.
" " 2 " 8 "
" " 3 " 2 "

3rd. With the preceding tube having the disc of soft iron placed within it on a level with its polar surface,

At a distance of 1 *millimètre* 37 *grammes*.
" " 2 " 13 "
" " 3 " 4 "

4th. With the tube of iron fitted with the disc at a distance of 5 *millimètres* below the polar surface,

At a distance of 1 *millimètre* 25 *grammes*.
" " 2 " 8 "
" " 3 " 2 "

These experiments show that the greater power possessed by electro-magnets having a solid core of soft iron is independent of the mass of the metal, and is due to the extent of the polar surface. Thus a simple disc of iron placed in the orifice of the hollow cylinder was sufficient to render the attractive force of the latter equal, or very nearly equal, to that of a solid cylinder of the same dimensions. The central portion of the soft iron cores of electro-magnets and magneto-electric coils is therefore inactive except in that portion where the attractive force is active or where magnetism is developed by induction. These observations apply not at alone to straight or bar magnets but, in even greater degree, to those of the horse-shoe form. They show, moreover, that any diminution of the polar surface in an electro-magnet must be detrimental to its application for a mechanical purpose.

ON THE LAWS OF ELECTRICITY IN MOTION.

BY RICHARD LAMING, M.R.C.S.

(Continued from p. 242.)

As the Editor has not been able to make out how the formula $P = \frac{S \times T}{L^2}$ is expressive of fact, which I learn by his note at foot of page 240, the generality of his readers probably lie under the same difficulty; I will therefore endeavour to remove it.

Let there be any number of homogeneous wires diversified in length and thickness, but each of uniform sectional area throughout. Let electricity be entering each of the wires by one end and leaving it by the other, without any question whence it is derived or where it goes. Let the intensities of the electricity be given; those as it enters the several wires being anything very great, and those as it leaves them, anything very small; the quantity of electricity available being in all cases unlimited. The formula will represent the quantity of electricity passing through either of the wires in a given time, that quantity representing the signalling power $=P$. For S is the conductivity of a wire of any sectional area (unaffected by length) under a given mean intensity; and T is some mean intensity, or motive tension (also unaffected by length) by which the impediments to velocity are to be overcome, and which mean intensity may be of any amount great or small. On the other hand L^2, which may vary within any limits, is compounded of, 1st, inertia, which varies as the square of the length of the wire, and, 2ndly, as the antagonism, which also varies as the square of the length of the wire, the two elements together being the resistance of my 14th Definition, which accordingly varies in that ratio.

The volocities are equal in all the parts of a given wire because the motive tension and the resistance vary together. For the motive tension progressively becomes less at successive places in the wire as the differences between the intensities at those places and at the termination of the wire diminish, which differences observe the ratio of the square roots of the intervening lengths. And again, the inertia and the antagonism become less with the same square roots, because the number of electrical movements remaining to be enforced becomes reduced in that ratio; the intensity of antagonism at every part of a cylindrical wire being constantly uniform from beginning to end.

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When a wire is compounded of mixed sectional areas, the formula will represent the physical action when it is made $P=\frac{S\times T}{L^{x}+A}$, in which A is the sum of the antagonisms; the intensities of the antagonisms at different places in the wire varying inversely as the squares of the sectional areas at those places.

The quantity of electricity passing any of the sections of a wire, whether the latter be of one thickness throughout, or of different thicknesses, will be constantly uniform; because as the sectional areas become less or greater, so in the same ratio will the rising or falling of the local intensities make the conductivities greater or less respectively.

The working power of a wire bears some relation to the magnitude of its smallest sectional area; for a smaller quantity of electricity in that section than in any of the other sections, will raise the local antagonism to equality with the utmost possible induction under the existing intensity.

If, still retaining the other conductions above specified, the intensity be unlimited, or sufficiently great, a conductor may be reduced to its constituent elements at any thin part of its length: for the induction at that place will rise with the intensity, the conductivity increase with the induction, and the quantity of electricity investing it with the conductivity, until that quantity become great enough to remove the physical cause of cohesion or tenacity as explained in Definitions 1 and 3.

ADDENDUM.

It is requested that the following be appended at the end of the 17th Definition, page 242, No. 73:

Supposing it to be all simultaneously acting upon an unit of quantity of common matter.

SUBMARINE TELEGRAPHY AND THE RETARDATION OF SIGNALS.

(Continued from p. 246.)

"Mr. Varley (to Mr. Whitehouse): Suppose the wire be charged with positive electricity, and you are sending a positive signal after that, will that increase or decrease the speed?—I never did that; the construction of these instruments was such that it must always be a negative current to go next.

"Would the signal go quicker when the wire was empty or when it was partly negative?—Quicker when empty. In fact, it was to retard the current and prevent it taking off the end of the dash, that I designed the antecedent compensation on purpose to remedy it, and put it into its place again.

"Do you think that system of compensation could be depended upon for that purpose?—Yes, most perfectly: and when once arranged, it is the easiest thing in the world. It is a mere piece of mechanical clockwork, which acts automically the instant you put down the key, and releases itself at the proper time.

"Chairman: It is entirely self-acting?—Entirely, without that arrangement our limitation of speed is much greater.

"Mr. Saward: Is it attached to the working key?—Yes; it is in fact a part of the key; the difference between simple reversals and working signals is much greater than 12 per cent. unless you can compensate in that way. With great accuracy of compensation you make the working speed nearly approach to the most rapid reversals, so that when we got 120 reversals through in a minute, we could have signalled words at high speed if very accurately compensated in that way: but without such compensation there would have been a reduction of speed to the extent of probably upwards of 40 per cent. required to signal words.

"Mr. Varley: Did you allow two currents for a dash?—The same time as two currents; we send a positive, and allow a lapse of time for what would have been the next negative.

"It was occupying the interval of three currents with one positive and one negative?—Yes.

"Did I understand you rightly to say when you were sending a succession of dots, take the letter V, which is composed of three dots and a dash, that the wire is empty after making the first dot?—No, because the blank and space following that dot has been produced by a current.

"It is a longer blank than usual, as if you were beginning a new word?—We will assume that all the currents are short circuited for four or five seconds before commencing a despatch. If then the first signal required were a dot, it is necessary that in this empty state of the wire it should be compensated antecedently, else it would be converted into a dash by marking too soon.

"On producing your first dot you send in a current which produces its mark, and then you send in after that dot a short portion of the opposite current?—An equal amount exactly, in order to terminate the dot at the proper time.

"An equal amount, and a little more, do not you?—We send in the alternate currents as they come from the induction coils to make the dots; when you come to the difference of time between the dot and the dash, you must compensate for them.

"You do not compensate for the spaces?—We compensate for them by the key exactly as we do for the dash, while the dots produce themselves; you have two keys at work; each key is held with the mechanism exactly the right length of time; you could not put it down before the proper time, at the time when the change took place the key was released; you could only raise it again at the proper time; there was the same mechanism for the dash key, and the blank key. If you printed the end of a word, you kept the blank key down during two intervals, the letter-space being one interval; the word-space two intervals which would have occupied the time of four currents; it is an extremely simple arrangement.

"In that way you got two and three-quarter words in a minute?—Yes, and we could have easily sent a good deal more; there was plenty of strength in the signals.

"With the battery what was the speed through that cable?—I am almost afraid to say; we had six, eight, and ten seconds for contact with Daniell's battery, before they could receive the shortest signal.

"What Daniell's battery was that?—We began with 480 pairs, and then I reduced them, arranging them for quantity, so that we worked from 25 to 50 cells, but never more.

"With 50 cells of what surface?—These batteries of Professor Thompson's were about 12 by 9, or something of that sort.

"Did you get the dots through in nine seconds?—It required 20 seconds to make a single dot, 10 seconds positive current to indicate the dot, and 10 seconds negative current to discharge the wire.

"For a dash could you work through it?—It was worked; the Queen's letter went through with the Daniell battery; we did not send a single message from this side with the induction battery; whereas every message from the other side was sent by the induction coils except these four words, "Daniell's now in circuit." Those were the only words that came from Newfoundland, except by my own induction coils and apparatus.

"Have you any idea of the speed of a message through, with 50 pairs of Daniell's battery, the number of words in a given space of time?—I doubt if at any time they exceeded the speed of one word in a minute; there were many stoppages in it, and many parts required repeating; they read off by half a degree of deflection upon their horizontal galvanometer.

"Mr. Saward: On the Newfoundland side?—On our side they were almost all read upon Thompson's mirror galvanometer. Some were received both by relay and by galvanometer, some came by relay alone; for the greater part of the time afterwards I kept Thompson's in circuit, and threw the relay out of circuit, simply because the other was more convenient and less liable to derangement in its action from the terrestrial currents. I was extremely pleased with it, and I printed some messages with my own hand from Thompson's galvanometer; some of them were recorded by relay with perfect accuracy; there were several recorded by relay and by Thompson's galvanometer on the same slip, so that there can be a strict comparison, and the relay in one or two instances is quite more accurate than the printing from Thompson's instrument. (*Several original message slips handed in illustrating these points.*)

"Chairman: Can you give any idea approximately, of the velocity of the messages received from Daniell's battery?—It was with very great difficulty that we could get anything through, as the signals from this end did not produce a deflection at Newfoundland of more than half a degree; all that was sent from this side we were obliged to work very slowly; if they had worked from that side with a Daniell's battery to us, we should have a fair comparison; it was not fair to compare the working from the lame side of the cable with the working from the perfect side; we did not get anything like half a word a minute through to them at the best time during my stay at Valentia.

"Mr. Varley: Do you think a word might have been got through in four minutes with Daniell's battery with such a cable as that if it were perfect?—Yes; a word in four minutes could have been easily got if the cable had not been injured. It ought to be done unquestionably.

"With regard to the cable at Keyham, did you try any experiments

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with Daniell's battery there before it went into the sea?—Yes. The Daniell's battery was fitted up and used on board the *Agamemnon*.

"Did you record any speeds there?—I tried the velocity. I did not try to record words.

"You do not think that increasing the size of the conducting wire will materially increase the speed of the transmission of signals?—I am quite sure that beyond certain limits, which I cannot yet define, the opposite will be the case, unless the quantity of electricity employed be increased in at least an equal ratio.

"A statement was made in a printed publication, shortly after the Atlantic Telegraph was established, to the effect that when the size of the conductor was increased, the speed would actually be diminished?—I think I can tell you exactly how that statement arose. Having the cable with six conducting wires in it, I was able to use the whole of the six conductors as six parallel conductors, increasing the area six-fold, and yet increasing its inductive surface at the same time six-fold. I was conscious that it was not like increasing the sectional area of a single wire six-fold, but increasing its surface only in the proper proportion; yet the results were so remarkable that I could not but be struck by them.

"Chairman: That produced the retardation?—In every instance, when I used two wires instead of one, the retardation was greater; when I used four it was further increased; and when I used six it was greater still. It is true that allowance must be made for the increase of surface being greater here than the fair proportion due to mere increase of sectional area would be; but the obvious increase of retardation was such that it at once arrested my attention. I had expected, as others did, and as some still do confidently, that by increasing the sectional area I should have got a higher speed; at all events, if it had not resulted in increased speed, I expected that by increasing the conducting power I should have got my signals heavier and stronger. I got them weaker and slower, in opposition to all one would have noticed in overground wires. I got literally less current, and, of course, because more remained on the surface.

"From that experiment you think that increasing the size of the wire would not materially increase the speed?—I do not know from what sized wire you propose to start as a minimum, nor am I prepared to say how far you ought to go in that direction; there are certain limits which would put a stop to it."

(*To be continued.*)

ON ELECTRIC AND COSMICAL PHENOMENA.

BY ADMIRAL FITZ ROY, F.R.S.

(Continued from page 243.)

The heated ether of earth may have been *known* by the terms negative, resinous, or minus electricity—although such words seem now to indicate one and the same state or condition of a principle, or influence, that varies in equilibrated tension according to circumstances—certain temperatures, states of matter, and *relative* expansion or compression.

Atmospheric currents seem to be electrified *(or etherised?) differently*, when proceeding *from* the torrid zone, as compared with their state while coming from a pole. And their inter-action or friction, in crossing, *super-passing* or otherwise affecting each other, may cause electro-magnetic '*earth currents*,' or telegraph 'wire disturbances:' notwithstanding that such phenomena are found to occur rather before any considerable changes of air currents (winds), whether from tropical to polar, or the contrary, are noticed. These changes are not necessarily violent; on the contrary, they are sometimes so gradual as to be scarcely remarked by general observers: but no important change or alteration of wind happens (as far as the writer is yet aware without some of these remarkable supposed indications of such aerial collisions.

Auroras and '*magnetic storms*'—or disturbances of magnets at observatories*—have been noticed as synchronous with earth currents along telegraph lines; and it is at all events a popular belief that strong winds usually follow auroras.

In Great Britain, the action of a polar current is shown by 'deflections' and other disturbances chiefly along the wires that run eastward, and to the north, from London. Deflections on the western and southern lines (*from* London) *seem*, as yet, to indicate appulse of a tropical air current—principally.

Deflections (so called), on all lines, show general disturbance of the atmosphere, by collision of currents—and are premonitory.

These occasional, but apparently *periodic* effects, seem to be closely correlated to those aerial overflowings in the torrid zone which have been described in the eighteenth chapter of this book.

Supposing that *continuous* streams are caused from upper tropical regions toward each pole (as there expressed), and with return currents from the poles: such horizontal and derivative motions would increase, decrease, or vary, like tidal *currents* occasioned by great tidal elevations or depressions. 'A continued stream may be produced by a succession of impulses, as a rotatory system of waves may be kept in constant circulation by impulses received from the adjacent tides.'*

If these views are based truly, and are legitimate inductions from facts, *solar action* may be shown to vary in its *effects*, during a certain number of years, in addition those ordinary consequences of annual changes exemplified in seasons.

May not *decennial*, or other variations of solar causation,† be traced indirectly, if not indeed directly, by prolonged observations of these mysterious currents—already referred by some philosophers to *temperature* within the earth,‡ or, by others, to the direct action of our great luminary?

Seeing that impulsion, or forcibly sudden impact, causes heat if not also fire, may not *prolonged* compression induce slow combustion, as effect of ether and oxygen?

Polar currents of *cold* air, much etherised, may have an excess of plus, vitreous, or positive electricity. Tropical (*warm*) ones may be minus or negatively electrified? Or conversely?

In regions where *extreme* atmospheric qualities approach, or meet—as in or near the tropics, where air and water are much heated—while *space above* remains cold, and where mountains reach to a climate cold even in summer—lightning and thunder-storms are very frequent.

On the other hand—in the icy high latitudes of polar regions—very seldom is thunder heard, and rarely is lightning seen.

But the aurora is *very* frequent, and at times has *seemed* to be near—even close,§ as if within a few miles.

May not auroral exhibitions—so beautiful, and occasionally so *extensive, though synchronous*—be caused by *inter-crossing* currents of air that develop electric (or etheric) light in our atmosphere—chiefly where it approaches space, is incessantly whirled round as earth rotates, and is separated—while confined—at its *cold* outer limit?

What an electrician can effect in a room, by a machine and exhausted receiver, may surely take place, on an immeasurably greater scale, in atmosphere, or in the *comparative* vacuum near its outer limits.

Cold air, in polar regions, having much ether (or electricity), any friction of inter-crossing air currents or otherwise, may cause its ready development.

Are not the working of an electric apparatus, rubbing a cat's back, combing hair, or even the harshness of one's skin, familiar evidences of a state of air extremely different from that which accompanies a tropical current of wind?

Ozone is prevalent with tropical winds, especially near the sea: but it is not so with polar wind, unless a temporary and merely *returning* current of tropical air.

Northern Lights,' 'Merry Dancers,' 'Streamers' of various bright colours, at times almost blood red—illuminate the polar regions, are sometimes seen in the middle latitudes, and, though rarely, near the tropics.

Cold—excess of ether or electricity, dry air, and an upper, or *commencing* contest of aerial currents, seem to be invariably present when aurora is conspicuous.

The magnetic influence of ether (in electro-magnetism) is extremely remarkable—so little need there be of a merely *material* connection between a magnet in air, and iron or steel which it affects. That magnetic (electric or *etheric*) influence is not stopped, or entirely cut off, by glass, is shown by the action of a magnet on the steel index of a Sixe's self-registering thermometer; or by a compass needle, entirely surrounded by a hollow glass sphere—and in other experiments.

The attraction existing between electric ether and iron seems to be felt *similarly* to that of our earth and ether in space, although in an immeasurably less degree. In each case, as supposed above, a dielectric, already saturated with ether in a latent state, is interposed—whether glass, or the atmosphere.

Imponderable electricity, or ether, has had its *effects* weighed by a delicate balance‖ and its velocity measured¶ mathematically as well as practically.** Apparently diffused everywhere, in and through every kind of material, perhaps throughout all space—surrounding closely and actually separating molecules,†† if not atoms, even *ultimate*

* C. V. Walker, and Balfour Stewart, F.R.S., in Phil. Trans., 1861 and 1862.

* Whewell, Phil. Trans., 1836, p. 299.
† Schwabe and Sabine, Pres. R.S.
‡ Airey—Astronomer Royal.
§ Ross's Arctic and Antarctic Voyages—Scoresby, and others.
‖ Snow Harris.
¶ Thomson.
** Wheatstone, and others.
†† Higgins—Atomic theory.

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particles of matter—it may be admitted to be the *principal agency* that is traceable in all our mundane, if not in all cosmical operations.

Nevertheless, it is unquestionably a mere instrumental means. It has not been proved to affect anything except by such ordained laws as can partly be traced by man. It does not act till forced by some change of condition—of temperature—or of equilibrium—and, for our beneficial use, it is sufficiently within human control.—"*The Weather Book.*"

MAGNETIC STORMS.

The Friday lecture at the Royal Institution was by Mr. Balfour Stuart, "On the greater Magnetic Disturbances or Magnetic Storms." Besides the ordinary changes on removal to different geographical regions, and the usual diurnal and other periodical changes, the suspended magnetic needle is subjected, at irregular intervals, to sudden and abrupt disturbances, known as "magnetic storms," but here the likeness to ordinary atmospheric storms ceases, for an atmospheric storm may be very severe in Europe and yet may not happen in America, while a magnetic storm is felt all over the world. The theory of magnetic storms as laid down by Mr. Stuart is that they occur simultaneously all over the earth; that they have a daily period not depending on the heat of the sun; that they have the same ten-yearly periods as the sun-spots; that they are associated with auroras and earth-currents, which latter appear to be induced currents, due to those sudden and abrupt changes of the earth's magnetism which magnetic storms denote; and that they are of two kinds taking place simultaneously, the effects on the needle being the combined result of both. On September 1st, 1859, it is thought the sun was caught in the very act of creating a disturbance. Mr. Carrington was observing a spot when a bright spark of light was seen to move over its disk. He subsequently obtained the photographic records of the variations of the magnet made at all the principal observatories, and found a magnetic disturbance or storm had taken place coincidently with this occurrence on the surface of the sun. Earth-currents are currents of electricity supposed to be traversing the earth, and are caught up by the railway telegraph wires, at times interfering altogether with their manipulation. In America, at the date in September referred to, they were so strong that the telegraph could be worked without any batteries. The maximum number of solar spots occurred in 1828, 225; 1837, 333; 1846, 330; 1839, 205 spots. These were also years of great magnetic storms.

In the production of auroras the earth must be looked upon as the iron core of a Rumkorff coil, the lower strata of the atmosphere as insulants, the upper strata as the secondary wires. When a sudden and abrupt change takes place in the electrical condition, a discharge follows;—if from excess of electricity, in one direction; if from a diminution, in another.

If the sun can produce auroras on the earth, why are they not possible on the solar atmosphere? Mr. Stuart thought the "red flames" observed during the late total eclipse by Warren de la Rue, Airey, himself, and others, might be auroras. The height of those red flames, 170,000 miles, was so great that he was not disposed, considering how vastly the gravitation of the sun must exceed that of the earth, to admit such a volume for the sun's atmosphere. Terrestrial auroras were often estimated as occurring at an elevation of a hundred miles; and as they possess an actinic power, carefully-taken photographs may lead to the ascertaining the height of our own atmosphere. For, as Gassiot has shown that no electrical discharge will take place in a perfect vacuum, the height of the atmosphere, and, perhaps, the nature of its components in those elevated regions, may be made out by examination of the auroral light. But these latter remarks of Mr. Stuart seem to us to negative his conclusions respecting the solar red flames, or, at least, those relating to the thickness of the solar atmosphere; for as no electric discharge can take place *in vacuo*, therefore the solar red flames, if auroræ, must take place *within* the solar atmosphere; and if so, then the solar atmosphere must be 170,000 miles thick. Mr. Stuart concluded his lecture by notifying that 1868 would be a year of maximum solar spots and magnetic disturbances, expressing a hope that our own and foreign Governments, as well as meteorologists and electricians generally, would be provided with instruments, and would undertake the labours of observation at various stations to gather conclusive evidence, if possible, on the interesting question of the relationship of the solar influence to our magnetic phenomena.

CATALOGUE OF BOOKS AND PAMPHLETS ON ELECTRICITY, &c.

MR. L. CLARK'S LIST *(continued)*.

1856—Callum, David Mc.—

[The Globolype Telegraph, a recording instrument by which small coloured Balls are released one by one and made to pass over a series of inclined planes by the force of their own gravity. Invented by David McCallum, of Stonehouse, Devonport. London: Longmans, Paternoster Row. 1856.]

1856—Watkins, Francis.—

[A popular Sketch of Electro-Magnetism or Electro-Dynamics, with numerous woodcuts of the most approved apparatus for illustrating the principal phenomena of the science and outlines of the parent sciences of Electricity and Magnetism. By the late Francis Watkins. Second Edition, Revised and Corrected. London: Elliott Brothers, Successors to Watkins and Hill, 5, Charing Cross, and 56, Strand, and sold by J. Weale, 59, High Holborn. 1856.] 12mo. Woodcuts. Price, 1s. 6d.

1856—Elliott, Brothers.

[Descriptive Catalogue of Voltaic and Thermo Electric Instruments and Apparatus manufactured by Elliott Brothers, Successors to Watkins and Hill, 5, Charing Cross, and 56. Strand. London. Illustrated by 78 Engravings. Price, 6d.

1855-56—Various.—

[Our Magazine, a Monthly Periodical published during the years 1855 and 1856; containing Original Articles, chiefly contributed by the Officials of the Electric and International Telegraph Company. Edinburgh: Stevenson and Co. York: Goddard and Lancaster.] Small 8vo., 569 pages.

1856—Airy, G. B.—

[Account of Pendulum Experiments undertaken in the Harton Colliery to Determine the Mean Density of the Earth. By G. B. Airey, Esq., Astronomer Royal; from the Philosophical Transactions. Part I. for 1856. London: Printed by Taylor and Francis, Red Lion Court, Fleet Street. 1856.] 4to., 59 pages. Plates.

A Galvanic Circuit was used in these experiments.

1856—Breguet, L.

[Manuel de la Télégraphie Electrique, a l'usage des employés des chemins de fer. Par L. Breguet, Horloger-constructeur des appareils de l'Etat, &c. Troisième Edition, revue, augmentée, et accompagnée de gravures dans le texte. Paris: Victor Dalmont, Editeur, Quai des Augustins, 49. 1856.] Small 8vo., 107 pp. Plates.

1856—Du Moncel, Le Vicomte, Th.—

[Expose des Applications de Electricité. Par Le Vicomte Th. Du Moncel. Tome 1st and 2nd, Notions Technologiques et Applications Méchaniques de L'Electricité. Paris: Librarie de C. Hachette et Cie, Rue Pierre Sarrasin. 1856.] 8vo., 2 vols., 970 pages. Illustrations.

1856—Harris, Sir William Snow.

[Rudimentary Treatise on Galvanism and the General Principles of Animal and Voltaic Electricity, with brief Notices of the purposes to which it has been applied. By Sir William Snow Harris, F.R.S., &c., Author of Rudimentary Treatises on Electricity and Magnetism in this Series. With numerous Illustrations. London: John Weale, 59, High Holborn, 1856.] 12mo., 215 pages. Woodcuts.

1856—Bonelli, De G.

[Du Télégraphe des Locomotives, De G. Bonelli, Directeur des Télégraphes Electriques des Etats Sardes, Système destiné a Prevenir les Collisions sur les Chemins de Fer. Paris, Libraire Nouvelle, Boulevard des Italiens, 15, en face la Maison Dorée, 1855.] Pamphlet 16 pages.

1856—Gore, George, Esq.

[Theory and Practice of Electro Deposition, including every known mode of depositing Metals, preparing Metals for immersion, taking Moulds and rendering them conducting. By George Gore, Esq., Birmingham. London: Houlston and Stoneman, 65, Paternoster Row, and W. S. Orr, Amen Corner, MDCCCLVI.] 8vo., 100 pages. Cuts.

1856—De la Rive, Aug.

[A Treatise on Electricity in Theory and Practice. By Aug. De la Rive, Ex-Professor in the Academy of Geneva, &c. Translated for the Author by Charles V. Walker, F.R.S. Vol. II. London: Longman, Brown, Green, and Longmans, 1856.] Royal 8vo., in three vols. See 1853 and 1858.

1856—

[Nouvel Appareil Electro Télégraphique appelé Distributeur de depeches; mis en rapport avec plusieurs Amelioration de la Télégraphie Electrique, 1856.]

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1856—Cooke, W. Fothergill, Esq.

[The Electric Telegraph; was it invented by Professor Wheatstone? By Wm. Fothergill Cooke, Esq. Part 2, containing Arbitration Papers and Drawings. London: sold by W. H. Smith and Sons, Strand, 1856.] 8vo.

1855—Ganet, A.—

[Traité Elémentaire de Physique Expérimentale et appliquée et de Météorologie, avec un recueil nombreux de problèmes illustré de 532 belles gravures sur bois intercalées dans le texte. A l'usage des etablissements d'instruction, des aspirants aux grades des Facultés et des candidats aux diverses écoles du Gouvernement. Par A. Ganet, Professeur de Mathématiques et de Physique.

Sixième Edition, conforme au nouveau Programme, augmenteé d'un second appendix de problèmes, de 21 gravures nouvelles, et des Travaux les plus récents sur l'Electricité. Paris: Chez l'Auteur, Editeur, 52, Rue de Vaugirard. 1856.]

8vo, 797 pages; pages 500 to 524 on Magnetism; 522 to 583, Static Electricity; 584 to 715, Dynamic Electricity, &c.; 716 to 735, Metreologic, &c. Numerous cuts.

1756—Lovett, R.*

[The Subtil Medium prov'd, or that wonderful Power of Nature so long ago conjectur'd by the most ancient and remarkable Philosophers, which they call'd somtimes Æther, but oftener elementary fire, verify'd.

Shewing that *all* the *distinguishing* and essential qualities ascrib'd to Æther by them and the most eminent modern Philosophers are to be found in electrical fire, and that, too, in the utmost Degree of perfection.

Giving an account not only of the progress and several Gradations of Electricity, from those ancient Times to the present; but also accounting,

First, For the Natural Difference of electrical and non-electrical Bodies.

Secondly, Shewing the source or main spring from whence the electric matter proceeds.

Thirdly, Its various uses in the Animal Œconomy, particularly when apply'd to Maladies and Disorders incident to the human Body. Illustrated by a variety of known facts.

Fourthly, The method of applying it in each particular case; and

Lastly, The several objections brought against it accounted for and answered.

By R. Lovett, of the Cathedral Church of Worcester. London: for J. Hinton, in Newgate Street; W. Sandby, in Fleet Street; and R. Lovett, at Worcester. 1756.] 8vo., 141 pages.

ON GALVANISM, AND ITS EXTRAORDINARY MEDICAL EFFICACY.

BY M. LABAUME, F.L.S., SURGEON-GALVANIST TO HER MAJESTY THE QUEEN, &c.

The *medical properties* of Galvanism are—stimulant, derivative, resolutive, and deobstruent. Its remedial power, as a natural excitant of the vital forces, vastly exceeds its energy as a local application; for it has not only a most powerful influence on the nerves and muscles, but also on the arterial and vascular systems; for it increases the action of the heart and arteries, and, consequently, the fulness or frequency of the pulse, and sometimes both: it also equalizes animal heat, restores the balance of circulation, and exhilarates the spirits. Its beneficial effects on the glandular system are astonishingly great, for it promotes healthy secretions of the liver, kidneys, and other glands, as well as those of the stomach, bowels, and the skin. It removes spasmodic affections, and allays the morbid irritation of the nervous system, by its tonic and invigorating influence on the chylopoietic organs. Thus it not only restores corporeal strength, but also nervous, sensorial, and intellectual power. Galvanism is especially effectual in removing biliary obstructions, and in curing those chronic disorders of the liver, occasioned by a residence in hot climates, as well as torpidity of that viscus, induced by sedentary occupations, or intemperate habits. In these cases it has been found an *efficient* and *beneficial substitute* for mercurial medicines, as its action is exceedingly mild and perfectly safe, and does not entail those ruinous and distressing effects on the constitution, which generally follow a course of mercury. Galvanism is also the more desirable, because during its administration it does not require confinement to the house, or any other inconvenient restraint: on the contrary, air, exercise, and a generous diet, are found materially to aid its curative process.

It is also of that peculiar nature that it can be beneficially used by children, adults, and by the aged, in every hour of the day, and in every season of the year; in cold as well as hot, in wet as well as dry weather; and, from the experience of others, I can also say, that it is equally efficacious in every climate of the world.

I have found galvanism more efficacious in chronic disorders than mercurial purgatives, stomachics, tonics and nervines, and which I assert, after a more extensive trial of its agency than has ever been made by any practitioner in this or any other country: a fact which I am bound to announce on the responsibility of my professional and moral reputation. In all cases of a slight and trivial nature the beneficial effects of galvanism are immediately perceptible; but its greatest honour is derived from the cure of those chronic diseases which are beyond the reach of medicine. Galvanism has often produced the best results in the worst cases, and has afforded equal benefit to the sinking energies of old age, to an unnatural feebleness of youth, and to a premature senility of middle life. That both electricity and galvanism have been considered by the professors of the healing art as more powerful and more beneficial agents than the ordinary medical means may be justly inferred, because they have been generally recommended by them as the *dernier resort* in the most hopeless cases, and after every other means have proved abortive.

That galvanism generally effects a permanent recovery, is a fact of as much importance to the invalid as its efficacy in chronic disorders is to society at large. That this should be the case is not at all surprising, when we consider the nature of that philosophical agent, which differs so materially from drugs and chemicals. The galvanic fluid is not a compound, but a simple principle, incapable of analysis; it is developed by a peculiar chemical process, is perfectly free from all gross material atoms, and is totally unconnected with homogeneous or heterogeneous particles; it acts *immediately* on the nervous system, and exclusively on the parts which are subjected to its influence, without the aid of the digestive organs or the lymphatic system: This is not the case with medicines, which must pass through the digestive process and be taken up by the lacteals.

With powerful medicines an experiment can very seldom be made on the sick, without a beneficial or injurious result; and as soon as the physic is taken into the stomach it must be allowed to take its course, although the earliest effect it produces may denote its *inefficacy*. In those innumerable cases where the expected benefit does not ensue, but a mischievous effect follows its exhibition, what art can place the constitution of the patient in *statu quo?* This objection, which has been frequently made to the trial of new and powerful medicines, cannot apply to galvanism properly administered.

Many patients have, from a mistaken notion of the powers of galvanism, and a too sanguine expectation of obtaining rapid recovery from diseases of long continuance, relinquished its use after a short trial, which afforded them proportionate benefit, and thus discarded the only remedy capable of restoring them to health, because they did not *immediately* obtain perfect recovery. The absurdity of such conduct must be evident; especially when compared with the patience with which many of them had endured the daily exhibition of medicines for months, and some for years together. It appeared, because galvanism is not an ordinary remedy, these patients expected that it would perform miracles, and cure the most obstinate chronic disorders of ten, twenty, or thirty years' standing, in as many days, although those disorders had baffled the skill of the first practitioners of the age.

POPULAR ELECTRICAL SCIENCE.

On Wednesday, the 25th inst., an interesting lecture upon "Galvanism" was delivered by Mr. William Tonkes (an amateur) to the members and friends of the "Southville Band of Hope," at the new chapel, Southville.

The lecturer, after a few preliminary remarks upon the nature and origin of the science, proceeded to show how it might be studied at slight expense to the student, exhibiting a variety of batteries and other apparatus constructed by himself, explaining more particularly a neat form of the Daniell's cell, which, at a cost of sixpence, would produce very fair specimens of medallion copies.

Amongst the experiments, which were numerous and successful, we noted particularly a "revolving magnet," made by the lecturer, and described by him in the first volume of the Electrician. Two small carbon, and one platinum, cells only were employed, but by passing the current through an induction coil and fastening the vibrating armature a brilliant stream of light was produced at each terminal of the revolving magnet.

* This work was omitted from a previous portion of the Catalogue.

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A small voltameter was also exhibited, and the decomposition of water explained; the production of magnetism by the voltaic current was well illustrated by a powerful temporary magnet, and the series of experiments was concluded by the deflagration of iron wire, and firing a cartridge by heating platinum wire.

ON THE LONG SPECTRUM OF ELECTRIC LIGHT.*

BY G. G. STOKES, M.A., D.C.L., SEC. R.S., LUCASIAN PROFESSOR OF MATHEMATICS IN THE UNIVERSITY OF CAMBRIDGE.

Introduction.

The experimental researches described in a former paper† led me indirectly to the conclusion that the electric spark, whether obtained directly from the prime conductor of an ordinary electrifying machine, or from the discharge of a Leyden jar, emits rays of very high refrangibility, surpassing in this respect any that reach us from the sun—and that these rays pass freely through quartz, while glass absorbs them, as it does also the most refrangible of the solar rays. I was induced, in consequence, to procure prisms and a lens of quartz, which were applied in the first instance to the examination of the solar spectrum, and which immediately revealed the existence of an invisible region extending as far beyond that previously known as the latter extends beyond the visible spectrum, and exhibiting a continuation of Fraunhofer's lines.‡ A map of the new lines was exhibited at an evening lecture delivered before the British Association at their meeting in Belfast in the autumn of the same year; and I then stated that I conceived we had obtained evidence that the limit of the solar spectrum in the more refrangible direction had been reached. In fact, the very same arrangement which revealed, by means of fluorescence, the existence of what were evidently rays of higher refrangibility coming from the electric spark failed to show anything of the kind when applied to the solar spectrum. At least, the only link in the chain of evidence which remained to be supplied by direct experiment, related to the reflecting power, for rays of high refrangibility, of the metallic speculum of the heliostat which was employed to reflect the sun's rays into a convenient direction; and this was shortly afterwards tested by direct experiment on rays from an electric discharge separated by prismatic refraction.

In making preparations for a lecture on the subject delivered at the Royal Institution in February, 1853, in which I had the benefit of the kind assistance of Mr. Faraday, recourse was naturally had to electric light, on account of the extraordinary richness which it had been found to possess in rays of high refrangibility. Although fully prepared to expect rays of much higher refrangibility than were found in the solar spectrum, I was perfectly astonished, on subjecting a powerful discharge from a Leyden jar to prismatic analysis with quartz apparatus, to find a spectrum extending no less than six or eight times the length of the visible spectrum, and could not help at first suspecting that it was a mistake arising from the reflection of stray light. A similarly extensive spectrum was obtained from the voltaic arc, and this was sufficiently bright to be exhibited to the audience, the arc passing between copper electrodes, and the pure spectrum formed by quartz apparatus being received on a piece of uranium glass cut for the purpose. The spectrum thus formed was found to consist entirely of bright lines,§ whereas the spectrum of the discharge of a Leyden jar had appeared (perhaps from not having been truly in focus) to be continuous, or at least not wholly discontinuous.

The mode of absorption of light by coloured solutions, as observed by the prism, affords in many cases most valuable characters of particular substances, which, strange to say, though so easily observed, have till very lately been almost wholly neglected by chemists. Having obtained the long spectrum above mentioned, I could not fail to be interested with the manner in which substances, especially pure but otherwise imperfectly known organic substances, might behave as to their absorption of the rays of high refrangibility. But the difficulties attending the habitual use of a nitric acid battery of thirty or forty cells, deterred me from entering on this investigation, and I determined to confine myself to the solar spectrum.

On account of some inconvenience attending the tarnishing of the speculum of my heliostat, I was induced to order a quartz plate, intended to be either silvered or coated with the usual amalgam of tin. On trying on a small scale the reflecting power of such plates with respect to the invisible rays, which may be done by means of fluorescence almost as easily as if those rays were visible,‖ I noticed a remarkable falling off in the reflecting power of the silvered plate for the most refrangible of the solar rays, which I readily found was due to a peculiarity of the metal silver. This metal is highly reflective for the invisible as it is for the visible rays up to about the fixed line S,* when its reflecting power falls off with remarkable rapidity, and for the more refrangible rays of the solar spectrum is comparable with that of a vitreous substance rather than with that of a metal. Steel, gold, tin, &c., showed nothing of the kind, but copiously reflected the invisible rays.

A few years ago, as Dr. Robinson was showing me some experiments with the induction coil, it seemed worth while to try whether the spark obtained when a Leyden jar has its coatings connected with the secondary terminals might not be sufficiently strong to exhibit by projection the long spectrum shown by electric light. On projecting a spectrum formed by a prism and lens of quartz on a piece of uranium glass, the long spectrum was in fact exhibited. It was not, indeed, so bright as when formed by means of a powerful voltaic battery, but, nevertheless, was quite bright enough to work by. It was discontinuous, consisting of bright lines. On changing the metals between which the spark passed, we found that the lines were changed, which showed clearly that they were due to the particular metals.

A wide field of research was thus thrown open to any one taking the very moderate trouble attending the use of an induction coil. It remained to study the lines given by different metals and gases, and the absorbing action of various substances with respect to the invisible rays of different frangibilities.

Various observations were made from time to time in this subject. As regards the metallic lines, it is perfectly easy to view them at pleasure; but to obtain faithful delineations of them is another matter. Even an accomplished artist would find difficulty in obtaining by mere eye-sketching a faithful representation of an object which requires to be seen in the dark. I tried different methods without being able to satisfy myself as to the accuracy of the drawings which could be thus obtained, and frequently thought of resorting to photography.

Meanwhile the mode of absorption of the rays of high refrangibility by a good number of substances was observed. Nothing is easier, to a person provided with a cell with parallel faces of quartz, than to observe, by means of fluorescence, the mode of absorption of these rays by a given solution; but to draw safe conclusions as to the optical character in this respect of the substance deemed to be in solution is not so easy as it might appear; for the rays of high refrangibility are liable to be absorbed by an exceedingly small amount of an impurity which may chance to be present without the observer's knowledge. Thus I found that about a quarter of a square inch of clean filtering-paper sufficiently contaminated the water contained in a small cell to interfere sensibly with its transparency, Should the solution be transparent there would be no difficulty, for the effect of an impurity would not be to render transparent a solution which otherwise would be opaque. Should it, on the other hand, absorb the invisible rays, or some of them, with great energy, or in a peculiar manner, we might again conclude that we had obtained the true character of the substance deemed to be observed. The most remarkable example of this kind which I met with among inorganic colourless solutions was in the case of nitric acid and its salts, such as nitrate of potash, soda, ammonia, baryta, which absorb the rays of high refrangibility with great energy and in a peculiar manner, exhibiting a maximum of opacity followed by a maximum of transparency, beyond which the absorption becomes still more energetic than before. But if the solution should be found to absorb the rays of high refrangibility with only moderate energy it would be left doubtful whether the observed absorption might not be due to some impurity; and I did not see how this doubt could be solved otherwise than by a laborious system of recrystallizations.

After having obtained these results, I found by conversation with my friend Dr. Miller that he also had been engaged at the same subject, working by photography, and had prepared a number of photographs of metallic spectra, and studied by the same means the absorption of the rays of high refrangibility by a great variety of substances, chiefly inorganic acids, bases, and salts, and the commoner organic bodies. Although a large part of the task which I had proposed to myself has thus been accomplished in another way, there are many results which I have met with which are not likely to have been obtained by one working by photography, and I have therefore thought it well to draw up a paper embodying these results, and thus forming, as it were, a supplement to the paper by Dr. Miller.

* Abstract from the *Proceedings of the Royal Society*.
† "On the Change of Refrangibility of Light," *Phil. Trans* for 1852, p. 463.
‡ Ibid., p. 559.
§ *Proceedings of the Royal Institution*, vol. i. p. 264.
‖ *Philosophical Transactions* for 1852, p. 537.

* According to the notation employed in the map published in the *Philosophical Transactions* for 1859, plate xlvii. In this plate the group S should have been represented as three lines, of which the middle (specially named S) divides the interval between the first and third in the proportion of three to two nearly, the spaces between the lines being a little darkened by shading.

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The Student.

SECONDARY BATTERIES.

(Continued from p. 234.)

In the secondary combination now to be described, a solution of the nitrate of zinc is submitted to electrolysis. This salt may be obtained either by dissolving metallic zinc in nitric acid (in which case the nitrate of ammonia is also formed), or by decomposing a solution of nitrate of lime by sulphate of zinc. To the nitrate of zinc, used in the secondary cell, may be added a portion of the sulphate of the metal. The cell is constructed with a negative element of platinum contained in a porous vessel, and with a hollow cylinder of zinc, surrounding the latter, for the positive. The porous and the outer vessels are both filled with the mixed solutions of nitrate and sulphate of zinc. To charge the secondary couple, the zinc, as in the previous instance, is connected with the zinc pole of the primary battery; the platinum being attached to the positive pole. A current of considerable tension is generated by this arrangement; and with large and closely approximated surfaces powerful effects of "quantity" would, doubtless, be obtained. We do not anticipate, however, that this combination will be found generally to give such satisfactory results as that which has been, and that next to be, described. It affords, nevertheless, a good illustration of the principles upon which the construction of secondary batteries depends; and, as we have been enabled to bestow but an imperfect investigation upon secondary couples formed by the decomposition of a *nitrate*, it may probably be improved upon by some of our experimental readers.

We can strongly recommend to the student the following combination, viz.:—for the negative element a cylinder of lead, and for the positive metallic mercury (which, to save metal and expose a larger surface, may be disposed as a cylinder within a porous vessel of peculiar form). The exciting fluid is a solution of salt in water, or in dilute sulphuric acid. The following details give one mode of constructing the couple. Within a porous vessel cement a solid cylinder of wood (which may be done by heating the vessel and inverting the cylinder of wood with a small piece of gutta-percha fastened to its lower extremity) in such a manner as to leave a narrow interior space to contain mercury. To the wood may be attached a wire in metallic contact with the mercury. A hollow cylinder of lead is constructed of such a size as to surround the porous vessel, leaving an interval of about a quarter of an inch. To the lead is attached a second conducting wire. The two elements are then to be placed in an outer vessel of sufficient size just to contain them, and the empty spaces filled up with a saturated solution of salt in water, or, if greater "quantity" be required, a saturated solution of salt in dilute sulphuric acid (about 1 in 7—previously allowed to cool). The wire in contact with the mercury is attached to the zinc pole of the primary battery, the lead being connected to the positive pole. By the action of the current from the primary battery, the mercury becomes converted into an amalgam of sodium (from the chloride of sodium, *i. e.*, common salt), while the surface of the lead becomes covered with the peroxide of the metal. It will be readily understood, therefore, that this secondary couple, when charged, constitutes a most powerful voltaic arrangement. It may be used for any length of time without requiring the addition of salt or acid, all that is necessary being occasionally to replace the water lost by evaporation.

We have adverted to the fact that where it is desired to obtain high tension effects from a number of secondary couples, by the action of a primary battery of small power, a *commutator* is required alternately to establish the connection for charge and the connection for the tension current. There is some difficulty in constructing an apparatus at once simple and efficient for the purpose of alternately connecting the similar and the opposite elements of a number of voltaic cells. Such an apparatus, if contrived, would be of frequent use not only for utilizing the properties of secondary voltaic arrangements, but for ordinary voltaic batteries, which, according to the purpose for which they are employed, may require to be connected for tension or for quantity. We have constructed one or two instruments to act as commutators in the cases we have mentioned, but as they do not answer the purpose in view so perfectly as to leave nothing further to be desired, we shall be glad of any suggestion on the subject that may be offered by those of our correspondents who may undertake the solution of the interesting mechanical problem herein involved.

INDO-AUSTRALIAN OVERLAND AND SEA LINES.

[In reference to the subject-matter of a letter from Mr. W. B. Passmore in our 70th No., we now publish the following correspondence relating to the Australian system of telegraphs.]

90, *Cannon-street, E.C.*
14th March, 1863.

G. S. Walters, Esq.,
Agent-General for South Australia,
London.

Dear Sir,

Following my letter of the 26th February last, I beg to address you again with respect to the relative merits of the Indo-Australian Overland and Sea Lines, because I think it is of the greatest importance that the various Colonial Governments should well consider the question in all its bearings before they commit themselves to the adoption of any scheme that may be submitted to them.

Many schemes have been propounded: amongst others, Mr. Gisborne proposes to lay submarine cables from East Java, round the coast to Moreton Bay, as follows, viz.:—

Banjoewangi to Coepang (Timor)	590 knots.
Coepang to Port Essington	525 „
Port Essington to Cape York	635 „
Cape York to Cleveland Bay	619 „
Cleveland Bay to Moreton Bay	655 „
Total	3,024 knots.

At an estimated cost of £1,100,000,

What the probable maintenance cost of this line may be, it is impossible to estimate; I observe it is put at £18,000; but should it be found necessary at any time to lift the cables for repairs, cutting out damages, and splicing in new lengths, this amount would probably be doubled: at any rate, there is so much risk attached to the maintenance of cable along shore, that I do not think any reliable estimate can be formed.

When Mr. Gisborne's scheme was proposed in 1859, no information whatever was possessed regarding the interior of the continent of Australasia: it was at that time vaguely considered that the country consisted of either bog or desert, that it was unfit for settlement, and that there was no possibility of establishing a road across to the north coast: it followed, therefore, as the necessity for communication with England by the electric wire was more and more felt, that a much larger amount of attention was bestowed upon that circuitous route than its merits deserve.

Since then, the valuable information communicated by Dr. Mueller, by Mr. Stuart, and others, proves beyond a doubt the practicability of carrying an overland line across the continent. The country is mainly pastoral, and from data which can, I think, be relied on, the cost of maintenance of such a line would not be great, as the stations could be located in the vicinity of cattle runs, thereby encouraging persons of intelligence to locate themselves as inspectors of the line.

From Mr. Stuart's paper, which was read at the Royal Geographical Society on Monday evening, it appears a portion of the country will be speedily occupied, the major part being rich and adapted for the carrying of flocks; and from the important advices just received by the present mail it appears that the country in Mr. Stuart's track is already being followed up with sheep and cattle, and occupied

There cannot be a doubt that land lines are much to be preferred to sea lines, even should the mileage be somewhat extended; but in this case the total mileage is not extended, for the overland route hereafter pointed out is by far the shortest and most direct,—saving in fact 1,000 miles of the *total* length of wire, besides substituting land communication in lieu of 2,000 miles of sea line.

In this case there will also be the important additional advantage that the erection of the telegraph overland will greatly stimulate the occupation of the country, and it is the opinion of authorities at Sydney Melbourne, and Adelaide, that small settlements along the line would be speedily formed, as is in fact taking place, and that by degrees the settlers would advance from station to station, until the whole line be occupied, and thus a good outlet opened up for the produce of the Colonies to the Indian and Chinese markets.

A most important feature in favour of the overland route must not be lost sight of; namely, that the messages could be transmitted across the continent at a much greater rate of speed than through the sea line; the messages being sent entirely across the continent without any break, whilst the cable would have to be divided into sections, and it would be necessary to receive and re-transmit each message at the end of each section.

I consider the overland main line should be carried, as far as is practicable, through the centre of the continent to a point which may be decided upon, where the systems of the respective colonies could be connected up to it: thus giving equal facilities to all the inhabitants of the eastern, western and southern parts of the vast continent, as well as to those of the future northern settlements.

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The saving in money would be enormously in favour of this route, as against Mr. Gisborne's scheme, as will be seen by the following figures, viz.:—

Submarine from East Java to Timor...	590 miles.	
Ditto from Timor to nearest landing place on north coast of Australia	350 „	
	940 „	
At say £250 per mile		£237,000
Land section, say 1,100 miles from the landing on the coast to the before-named central point not exceeding		175,000
		£412,000

Or £680,000 less than Mr. Gisborne requires for the cable to Moreton Bay. This should be well considered by the guardians of the people's purse.

It is estimated that the maintenance of the land section would be as follows: say a station on an average every 100 miles, with one assistant, and in some cases two assistants at each. Taking the annual expense of each station at £800 (a very outside estimate), × 12 gives £9,600 per annum.

Mr. Gisborne has now, I believe, proposed a second plan, namely, to carry his cable from East Java to the Gulf of Carpentaria, with a land line to Moreton Bay.

By this altered proposal the length of the cable would be reduced to about 1,855 miles, and incur a land section of about 1,100 miles.

The cable thus reduced he reduces in cost to ...	£710,000
But a land section from Gulf of Carpentaria to Moreton Bay would be necessitated, and this say 1,100 miles at my estimate as before	175,000
	£885,000

Or £472,000 more than the proposed direct overland route through Central Australia.

The maintenance of the cable in this case I cannot estimate reliably, whilst the land section would cost £9,600 as estimated above.

Mr. Gisborne apparently proposes to secure a monopoly of communication with Australia for thirty years: this, in view of the extraordinary development of the colonies, is out of the question, for judging from experience already derived I am convinced that a single line will be found totally inadequate for the transmission of the messages. This view I am glad to see is entertained by the Home Government, as I find Lord Carnarvon, in his despatch of the 2nd of May, 1859, distinctly states that H. M. Government had decided to grant "no more exclusive privileges."

Finally, I submit that the time has now arrived for strongly recommending to the consideration of the Governments concerned the carrying out of the proposed land route across the continent, to the point they may determine, as before suggested, which I entertain no doubt could be completed for the amount I have stated; thus opening up a route for the carriage of the produce of the country to the Indian Ocean, and greatly facilitating the settlement of the districts through which the line may pass.

In confirmation of my view, I may add that the Superintendent of Telegraphs at Melbourne, in reporting to his Government on the possibility of erecting a line to Port Essington, or some other point on the north coast, expresses an opinion "that the successful issue of such an undertaking would be productive of incalculable good to the country, as in fact practically securing the speedy settlement of that portion of Australia, and affording a new field for the untiring enterprise and perseverance of the British colonist." The Superintendent of the South Australian system has also most strongly pointed out the practicability of the route proposed, and as being undoubtedly to the benefit of the whole of the colonies.—I am, dear sir, yours faithfully,

Wm. B. Passmore.

London, 16th March, 1863.

From G. S. Walters, Esq.,
Agent-General of South Australia,
To Cromwell F. Varley, Esq.,
Electrician and Engineer of the Electric and International Telegraph Company.

Dear Sir,—Would you have the goodness to run your eye over the letter from Mr. Passmore to me, of which I want to take printed copies for distribution in the colonies, &c.

If you approve of it would you have any objection to append a few lines stating your general approval, with any remarks you might think proper to add.—Believe me, dear sir, yours very truly,

G. S. Walters,
Agent-General for South Australia.

Kentish Town, March 17th, 1863.

To G. S. Walters, Esq.,
Agent-General for South Australia.

Dear Sir,—In answer to your favour of the 16th, containing a letter from Mr. Passmore, respecting the proposed telegraph from India to Australia, &c., I quite agree with his recommendation of a land line across the Continent, in preference to a series of submarine cables around the coast, and for the following reasons:—

1. The first cost of a land line is very much less.
2. The maintenance is much more facile and inexpensive.
3. Land lines being comparatively free from the effects of induction are manipulated with greater ease and expedition, and fewer errors creep into the despatches during transmission in consequence.
4. The various sections of land line can be united together by translating instruments, so as to afford direct communication over distances of even 2 and 3,000 miles at a good commercial speed. We often work from London to Petersburg direct, at a rate of 8 to 12 words a minute.
5. Submarine circuits, owing to the retarding action of induction, cannot be so united, without too great a loss of speed, unless the core of the cable be extravagantly large.

It may be doubted whether an aërial line can be constructed and maintained across the comparatively wild country of central Australia. This most important question has been solved in America between New York and San Francisco, a distance embracing more than three hours of longitude. This line of telegraph is entirely overground, and "crosses the snow-covered Sierra Neveda and the Rocky Mountains, passing through deserts and over fifteen hundred miles of country inhabited by savage tribes; the stations are from thirty to seventy-five miles apart." This line has been in operation for the last sixteen months with scarcely any interruption.

Mr. Gisborne estimates the annual cost of maintaining his submarine line and stations at £18,000. This amount cannot include any subscription to a renewal fund, which should not be less than £80,000 per annum for a line costing £1,100,000. The soundings seem too imperfect for the purpose of submarine telegraphy in this part of the world. This should receive the immediate attention of Government; the more especially as the numerous rocks and islands between Torres Straits and Moreton Bay seem to indicate "rough bottom." This is an additional reason for erecting the telegraph overland.

It is my firm conviction that as soon as one line is established many will follow, for it is obvious that one circuit will be insufficient for the demands of the country. From the perusal of "Stuart's Journal," the interior of Australia seems particularly well adapted for aërial telegraphs, and I would strongly recommend the less costly, shorter, and more expeditious overland route, to the coasting cables proposed prior to Stuart's discoveries.—I am, dear sir, very truly yours,

Cromwell F. Varley.

CONTINENTAL TELEGRAPH MESSAGES.

From the London Review.

A lively correspondence in the *Times*, between the Secretary of the Submarine Telegraph Company and one of its customers, with respect to the delay of a message from London to Florence in January, last invites us to examine the actual regulations for the despatch of English telegrams to the Continental States. The gentleman who humorously signs himself "A Tortoise," and dates his letters from "The Slow Coach Office, Sluggard Square," might naturally be astonished when he found that, while the postal conveyance from London to Florence is accomplished on the fourth day, ten days were occupied in transmitting a message which ought with proper working along the lines of wire, to have been delivered within three or four hours. Mrs. Tortoise, whose name is Gallicised into "Miladi Tortue" by the gallantry of the Italian officials, though she did not arrive till the 17th in the fair capital of Tuscany, where the marital communication on the 7th had expected to find her, seems never to have received it at all; for she left Florence on the very day of her arrival, at an earlier hour than that at which the laggard message came in from Milan. In the meantime, she had got a letter from her husband, and he had got an answer from her. This will never do; and the explanation proffered, two months later, by the Continental Telegraph authorities, with their refusal to hand back to

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Mr. Turtoise the money which he had prepaid for their services, is most unsatisfactory. The blame, in this particular case, would appear to lie with the Swiss Administration; for the telegram reached Paris in four minutes from London, and it was safe at Lucerne before seven o'clock in the evening of the same day. There is a telegraphic line over the St. Gothard pass, with seven or eight stations between Lucerne and Milan; but an Alpine storm had swept away the posts and wires at some point along the mountain road, and the office in Switzerland, following its rule in such a case, thought proper to commit Mr. Tortoise's message to the ordinary post, under cover addressed to the nearest station-master in Italy whose portion of the line was in working order. As it happened, the St. Gothard road was for some days not only disfurnished of its telegraph apparatus, but impassible for the carriage of mails; hence the letter from Lucerne took a whole week in getting to Bellinzona, the first town on the southern side of the Alps, and was there again put into the post for Milan. It is probable that a few hours may also have been lost in telegraphing from Milan to Florence; but the main cause of delay was certainly the conduct of the authorities at Lucerne, or rather the faulty system of managing this department in most of the Continental States. This is a matter of so much commercial and political importance that we may now take occasion to remark upon it, with some practical suggestions of amendment.

It is known, perhaps, to all our readers, that all over the Continent, instead of being the property of private companies, as in this country, the lines of telegraph belong to the Governments, as well as most of the lines of railway, and that their mutual accommodation is prescribed by diplomatic conventions, like the postal treaties between foreign States. Throughout the French empire this business forms a special department of the Ministry of the Interior; and its regulations, collected in several volumes which are published from year to year, are sufficiently complicated and precise. The German-Austrian Telegraphic Union, which has its head-quarters at Berlin, extends over not merely all the States of the German Federation, but the whole of the Austrian Empire, including its Venetian, Croatian, and Transylvanian provinces; thus covering a vast space of Central Europe, from the Belgian to the Turkish frontier, and from the shores of the Adriatic to those of the Baltic Sea. A uniform set of regulations for the management of this great network of telegraphic wires, which traverse so many different States, is printed in the German language, and enforced by the superintendence of the Prussian Government, under treaty with its Federal neighbours. The kingdoms of Belgium, Denmark, Italy, and Spain, the Republic of Switzerland, and other independent sovereignties, have each its own separate administration. The powers of the State, in respect of this monopoly, are nowhere conceded to private adventurers, so far as concerns land telegraphs, but are reserved as jealously as the control of the Post-office, or the sale of tobacco, or any other item of fiscal revenue, deemed indispensable to the budgets of Continental rulers. Between themselves it has been usual for the Governmets of *pays limitrophes*, that is, those territories which border upon each other, to enter into certain stipulations or working traffic arrangements in this matter of telegraphic communications, but they have no direct dealings with the other telegraphic systems, which are separated from them by an intervening foreign administration.

The directors, therefore, of an English Company, such as the Submarine or the Electric Telegraph Company, must be content with such arrangements as they can make with the nearest Governments beyond the Channel or the North Sea, and leave it to those Governments—the French, the Belgian, the Dutch, the Hanoverian, or the Danish—to provide for the further despatch of messages sent from London. The office here engages to put upon the Continental telegraphs any messages entrusted to it in London; just as the South-Eastern Railway Company issues tickets for the conveyance of passengers over the foreign lines of railway, as far as Geneva or Vienna. In the case we have just noticed, it was the Vicomte de Vougy, Imperial Director-General at Paris, who had, at the instigation of the Submarine Company's Paris agent, to call the Swiss administration to account for the delay of Mr. Tortoise's message; and it was for M. de Vougy afterwards to insist on the repayment of the Englishman's money, or that portion of it at least which belonged to the telegraph in Switzerland. We do not, however, dispute the claim of Mr. Tortoise to the reimbursement of the whole sum, nineteen shillings altogether, which he had prepaid at the office of the London Company; that being a matter for the English law to decide, having regard to the contract, the guarantee, or the agency, which may have been undertaken by this Company, as to the further transmission of messages beyond its own lines. But it should be well understood, that redress for such grievances as Mr. Tortoise justly complains of must ultimately be obtained from a foreign authority, with which the English Company have no immediate correspondence; and that it is not in their hands, but in those of the French administration, to amend, if necessary, the existing arrangements for sending on their despatches through Switzerland, Italy, and Spain; and wherever, from the failure of such arrangements, an English customer has suffered damage, the appeal can only be made to conventions between those countries and France. The same remark will apply to those messages which go *viâ* Belgium. We believe that this department is very well managed, upon the whole, by the French and Belgian Governments. The want of punctuality and accuracy in foreign telegraphs is felt in a proportion exactly commensurate with their distance from our own shores. Those of Spain, Italy, Greece, and Turkey cause the most trouble and disappointment, both from their delays in forwarding or delivering the messages, and from blunders in copying them. The submarine lines of the Mediterranean, between Sicily and Malta and Alexandria, being under English management, work very well.

In reference to the case of this message from London to Florence, it strikes us that there was no obvious reason why the French Administration should have sent it through Switzerland at all. From Paris to Milan, by way of Savoy, the Mont Cenis road, and Piedmont, there is a telegraphic communication in about two hours. The authorities at Paris ought to have been duly apprized by the Swiss management of the havoc caused by the storm, which had made it impossible to send messages for Italy beyond Lucerne. We find in the Imperial decree of April 12th, 1856, which embodies the convention still in force between France and several of the neighbouring States, Switzerland being one of them, a clause obliging each Government, whenever it shall, for its own convenience, put a temporary stop to telegraphic communication along its own lines, instantly to inform the other Governments of it; but we do not find any similar provision for the case of an accidental interruption. This seems to us a very grave defect in the international system. Switzerland was, in fact, obtaining money on false pretences if she purposely concealed the fact of the break-down of her Alpine telegraph from customers in Paris and London, who paid her for that service which she was unable to perform. There is another clause in the same convention which might probably be quoted as justifying the authorities at Lucerne for the way in which they disposed of this message when they could not send it on by the wires. It is clause 13, which directs that in such a case the station-managers shall send on by next post, or the next railway-train, a copy of the message, addressed to one of the stations on the further part of the line, beyond where the interruption has taken place. But we think it scarcely needs remark that the more useful course would always be, upon such occasions, to inform the senders of the message, behind, that the telegraph has ceased working from a certain point, so that they may send it, if they please, by a different route. If the Lucerne people, when they got Mr. Tortoise's despatch at seven o'clock in the evening, had signalled to the Director at Paris that they could not pass it over the Alps, it might have been put on the Lyons railway line, and safely and speedily delivered at Florence. The stupidity of their adherence to routine, in this instance, was enhanced by their probable knowledge of the state of the roads, as well as of the telegraph line, making them pretty well aware that the posted letter would undergo a considerable delay. In these circumstances, it is really provoking for Mr. Tortoise to be told, in reply to the demand for reimbursement of his money, which M. de Vougy has addressed to the Swiss management on his behalf, that they allege *le cas de force majeure*, or the physical impossibility of performing his errand, in support of their refusal to allow him what he had prepaid. So far, indeed, as the exceptions are to be inferred from perusing the rules upon this matter, they may plead clause 30 of their convention with France. It says that the whole of the money shall be repaid "in cases where the message has not reached its destination through the fault of the telegraphic service, or has been so much defaced and altered (*dénaturée*), that it does not fulfil its purpose; or lastly, if, from some cause or other, it arrives later than it would have done by the post;" there is, however, a general exception for the *cas de force majeure*. The total failure of this despatch might yet have been easily prevented, as we have shown, by a better arrangement between Switzerland and France. M. de Vougy should be ashamed to admit the plea of *force majeure*, till he has procured a revision of the international system with respect to these contingeneies of the telegraphic service.

We would also suggest, that the diplomatic influence of her Majesty's Government might be exercised with some advantage in persuading foreign States to reform this department of their administration for the greater convenience of British subjects using the telegraphic lines of the Continent; and especially that they

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should come to a distinct understanding as to the mode in which individual complants, or demands of restitution, are to be met. Nothing can be more loose and unsatisfactory than the practically irresponsible conduct of this service, at present, in most of the countries which are not in immediate communication with the English lines. In justice both to the Submarine and the Electric Telegraph Company of London, we believe that their efforts have been unremitting to obtain a reform, and that their agents at Paris or Brussels have never failed promptly to call for the repayment of the cost of messages which were spoiled or delayed in the sending abroad. In more than one case, with which we happen to be acquainted, the reply to such a complaint has been kept back for twelve months; and in one case for exactly two years, before the Administration, for example, of Wallachia could be prevailed upon, through the agency of the Prussian (or German) Administration, set in motion by that of Belgium, to credit them successively with the price of a lost message, for which the London Office had demanded restitution as soon as ever its miscarriage was known at this end. We cannot but think that if, with other commercial men in London, the numerous foreign merchants who reside here, Italians, Spaniards and Portuguese, Greeks and subjects of the Ottoman empire, would memorialize the ambassadors of their respective States to urge upon their own Governments at home an amendment of this matter, their action would have a most beneficial result. And it is to be hoped that Mr. Tortoise would then again come forward in the *Times*, with another effort of his dexterous pen, to advocate so desirable a reform,

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of The Electrician.

Sir,—I regret that your correspondent M., or any one who heard the paper, which I was requested to read before the Inventors' Institute, should have been left under the impression (I suppose from my failure in explaining myself), that I had any doubt as to the right form of cable for deep-sea work, or the rules to be observed in constructing it, so far at least as the mechanical part is concerned. Mr. Allan's cable has always recommended itself by its simplicity and correct mechanical disposition of material, to my most unqualified approbation, as far as I am a judge of such matters; but M. will allow me to say that I do *not* claim for seamen, that they are, or ought to be, the best judges of how a telegraphic cable is to be *made*, but only how it is to be *laid*. On this latter part of the subject, you seem to have apprehended my meaning; but others (among them your correspondent M.), appears to require from me more detailed explanations. After sincerely thanking M. for the generally candid tone of his letter, and the favourable opinion he is kind enough to express of my system, I proceed with your permission to give these.

First, as to the cable, its form and specific gravity: I laid down as an acknowledged rule, that cables must be specially constructed for the miles they were designed to occupy.

This is almost a self-evident proposition, and certainly ought to require nothing more from a seaman than the passing notice I gave to it. Next, that the weight suspended in water (under the axiom just noticed), should never be much more or less than half the breaking strain.

Thus the Atlantic cable designed for a route having a depth of about 2,000 fathoms should (according to this view, and for the mode of laying which I propose), be capable of bearing 4,000 fathoms of its own weight in water*. I do not indeed lay down what that weight is to be, or what the material, for this would be to trench on the Electrician's province, but I say that I can lay a cable from a cylinder revolving in water, which may be of such a proportion of tensile strength—I could not do so from a ship—I should wish it to be stronger, that is, capable of bearing more, if that were possible, without making it unduly light.

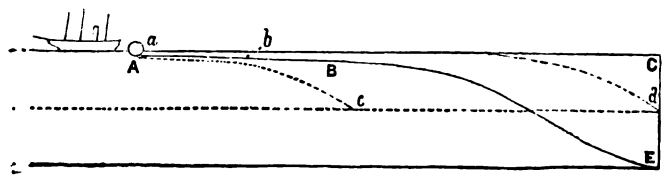
For I once more repeat that not by me, but by skilled mathematicians—of whose theory I, as a practical seaman, and a student of mathematics, can but express my humble approval—it has been amply laid down, and fully proved, that every cable has a normal rate of sinking due to its specific gravity. That this cannot in any case exceed in an ocean cable, if even it ever equals, the rate at which a sounding lead drawing down a fine line, descends. Therefore, this rate being two miles per hour, we can scarcely allow so much, certainly not more for any practicable ocean cable.

Also we must remember that the rate of ship in crossing the Atlantic is governed by the expenditure of coal, and could not be therefore put lower than five miles per hour, taking into consideration as well, that in proportion to the time of passage, is the danger from gales of wind, currents, &c.

I will take your correspondent's three miles per hour and show him what would be the objections.

With a ship alone and no cylinder, the ship with cable on board can barely stow her proper proportion of coals, say twelve days. She has to make her passage to the mid-Atlantic, occupying five days at least; she cannot run back paying out cable at nine or ten knots, but about five or six, and therefore takes the remainder of her coal to do it. If she went three knots per hour the distance being 1,000 miles, she would take 13 days, 21 hours*. Where is the coal to come from? She ought to have stowed 19 days' coal, which she cannot do. Again, if, with the cylinder, the retardation due to towing (and this particularly when not laying cable is sure to be considerable), would come in as a per contra to the increased stowage of coal which might now be possible owing to there being no cable on board, but even in this case five knots must be looked upon as the rate of ship, below which it is not desirable to go. A ship, too, steers badly in proportion as she goes slowly, particularly in a seaway. It is true that by going on the lowest grades of expansion, great gain may be effected in the expenditure of fuel, but it would not be wise in designing a cable to rely upon this, but rather on a well considered rate of sinking ensured by going close up to the practical limit of half the breaking strain.

Therefore, two miles per hour being the maximum rate of sinking of a practicable ocean cable, and five miles per hour being the minimum rate at which a ship, with or without cable, ought to attempt crossing the Atlantic under steam, or even, I will say, anywhere, to attempt laying an ocean cable, it follows that the curve which I have shown in the paper—upward or convex to the ocean level as originally laid down by Mr. Gravatt—will be formed, and that the difference between rate of sinking of cable two miles per hour, and rate of ship five miles per hour, *i. e.*, three miles, will at any given moment be



Rate of Ship, 5 miles.—Descent of Cable, 2 miles per hour. Curve of contrary Flexure.

lying near the surface of the ocean, exposed to a surface current. This length is constant, because whatever sinks is taken off from the bottom end, *not through the whole length*, for though the cutting descent does take place all the way along, yet the maximum effect is at the lower curve of contrary flexure, near the bottom. If when a kite is at a certain altitude the string were severed near the kite, a large part of the string would come down in a coil, or slack at the feet of the person holding it. This is caused by the resistance of air to the cutting descent, and the same action takes place with the cable in water, but in a greater degree. If the speed of ship were lessened to three miles an hour, there must still be a length of one mile on the surface, for the rate of sinking can, under no circumstances, be altered with a given cable. If, on the other hand, the rate of ship be increased, or slack be paid out to answer a strain produced by current, the whole increase goes to swell the quantity of cable lying along the surface. But if the depth be changed another law comes into operation. If the cable was capable of sinking, and did sink 2,000 fathoms in one hour, or from C to E during the time the ship was going from C to A, when the depth is changed to 1,000 fathoms it will have sunk to *d* in the first half hour, and to *c* in the second. Thus A B, the length exposed to surface current, is shortened to *a b*, or nearly halved, and in shoal water a catenary curve is soon obtained, a condition which, as well as the high specific gravity, favourably modifies the difficulties of laying with shallow water cables. But the distance A B, except in this instance, is affected by nothing else than the rate of ship, and specific gravity of cable.

I must apologise for what may be called "harping on one string," but really these curves are of such vital importance to the whole ques-

* If correctly made, the strength, conductivity, and insulation, will each be the greatest obtainable, with a given specific gravity, weight and bulk. *Deep-sea* cables have never been proved to require any outer protection, except from rude handling which ought not to be allowed.

* 3 k. by 24 equals 72 k. per diem.

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tion of submarine cable laying, that they can scarcely be too much dwelt upon.

I do not myself think it probable that even with a heavy cable weighing, say three or four tons per mile (if that were in other respects possible), these curves would be materially altered, for all such cables would probably have a considerably greater bulk, and it must be evident that a large proportion of the check to the sinking of any cable is made up by a resistance of water to cutting descent, which will increase as the cubes nearly of the velocity of sinking. From what I have here and elsewhere said, it will, I hope, be clear that all increase of bulk is to be avoided unless it gives great counterbalancing advantages, and that slowness of sinking, which some have sought to ensure by the use of buoys, &c., is an evil to be deprecated, not an advantage to be gained. The heaviest cable would be the best if it could, at the same time, have sufficient tensile strength for all our purposes, and did not tax our carrying powers too largely.

I am happy to see that my questions to Mr. Gisborne have brought out the fact that the perforated gutta percha was merely that with which we have all along been familiar, Mr. Siemen's case. Being covered with hemp, I am not surprised at the attacks of animalcules on that substance, and the strongest proof we have ever had that gutta percha will be exempt from such damage when not in combination with other materials, is to be found in the fact that instead of eating through it they evidently turned from it, as soon, and by as short a path as their peculiar formation allowed. Making, as such perforators do, a circular hole, they were forced to nick out the obnoxious material, but no doubt found it too tough and too little suited to their alimentary canal for digestion. Had such a story been fully borne out, we might, indeed, have given up all insulators, and waited for the development of uncovered wires or no wires at all, though at present I confess to an utter want of faith in either system. In the one case, because no power could be generated without consumption of material in the shape of wires, and it would not pay to be always laying cables. In the other because, as I said before, I do not see how a vagabond electricity is to tell, as Pompey said, "tother from which," even if the said vagabond ever consented to go across the ocean on such an errand at all.

J. H. Selwyn.

P.S.—Since I wrote the above I have received your last impression, and I remark with astonishment that while Mr. Gisborne persists in his attack on the durability of gutta percha, aided by his intimate friends the animalcules, Mr. Latimer Clark is no less confident that in its present state india rubber must not be trusted. Are these gentlemen, or either of them, prepared to tell us what we *may* use as an insulator, or do they mean to say conjointly that insulation is a myth and a submarine cable impracticable. This would at least be extraordinary in two such active promoters of submarines.

To the Editor of The Electrician.

Sir,—The letter of Mr. Latimer Clark respecting the Persian Gulf cable, which appeared in your journal of the 27th, cannot consistently remain unanswered.

It would argue but indifferently for the merits of the case with the public if the construction of this cable did not admit at least of a plausible defence, and the use of gutta percha as its insulator justified on apparently incontrovertible grounds. This your correspondent has so admirably effected, that, doubtless, to superficial readers, the why and the wherefore are satisfactorily demonstrated, especially with the weight superadded of the name of so distinguished an electrician and telegraph engineer as Mr. Latimer Clark. With all deference, however, we offer a few comments, which we do not disguise will be at issue with his views, as it is obviously necessary that caoutchouc insulation should be cleared of the indirect but damaging imputation which is cast upon it.

It may be thought that the defence of india rubber insulation would come with a better grace from some one uninterested in its manufacture, and this we are free to admit; but then there are some points of Mr. Clark's letter which could scarcely be so well replied to by any one else. And as to the general question of the relative values of the two gums for this purpose, it is already so plainly before the public (and every one has or may have, the means and opportunity of testing for himself which is the more superior, whether as to electrical qualifications, durability, or what not), as to justify no delicate scruples on our part in thus coming forward as the advocates of "india rubber" insulation, since, if our interests as manufacturers should lead us into error, it is easy for the merest tyro to refute us.

Mr. Clark states that "the Government Committee, in their Report on Submarine Telegraphy, spoke so highly of the qualities of india rubber as an insulator for telegraph cables, that it seemed not unreasonable to expect that the Government would, on the first occasion of their requiring a submarine cable, so far follow out the recommendation of the Committee as to employ this material as their insulator. Precisely, Mr. Clark could not possibly have expressed the general feeling of the public better.

But he goes on to say that notwithstanding this, the Government have not adopted caoutchouc insulation for submarine cables in India: and here we are bound to state that this is not a fact. We believe we are strictly correct in stating that it was in consequence of the heavy losses sustained by the use of gutta percha for telegraph purposes in India, that the Indian Council were induced by Sir W. Brooke to make a *fair* trial of coutchouc for the Persian Gulf cable. We were accordingly requested by Sir W. Brooke to furnish him with specimens for testing the insulation, the results of which were so satisfactory that we received an order in May, 1862, to construct 20 miles of coutchouc covered wire for that purpose. The following is an abstract of the agreement for its manufacture.

1. "The core to consist of 7 strands of pure copper wire weighing about 275 lb to the mile, and covered with india rubber weighing about 160 to 165 lb to the mile. The copper strands to be wormed with a thin layer of india rubber as in the specimen shown, and the core to be covered with a layer of tape.

2. "The core to be supplied in lengths of one mile at least, to be tested in "Reid's" apparatus at some place in London.

3. "The core to be tested in "Reid's" apparatus under a pressure of 600 lb to the square inch, then in a vacuum of 26°, and lastly in water of a temperature of 80° Fah., with a sand and water battery of 504 cells, and if found perfect after having been thus tested a written certificate to that effect will be given to Messrs. Wells and Hall previous to the core being removed from the place of testing, freeing them from all *subsequent responsibility should the core sustain any injury in its removal or from any other cause.*

4. "The india rubber portion of the joints to be made by Messrs. Wells and Hall, and the joints to stand the same electrical tests as the body of the core.

5. "The electrical condition of the core under the tests above named to be equal to that of the Malta and Alexandria core.

6. "The core to be subject to the approval of Sir W. O. S. Brooke, and any portions not approved by him to be replaced by Messrs. Wells and Hall.

8. "The whole twenty miles to be delivered in London within a period not exceeding three months from date of this memorandum."

The following is the result of the testing:—In testing for insulation a battery of 504 cells was used; one pair of cells giving a deflection of 60° on one of Reid's delicate galvanometers.

Date of Testing.	Temperature of Water.	Number of Length (1 mile.)	Loss of Insulation in Vacuo.	Loss of Insulation under Pressure.
July 29, 1862	74°	1	·25°	·5°
"	"	2	0°	0°
"	"	3	0°	0°
Aug. 5	"	4	0°	0°
"	"	5	0°	0°
"	"	6	0°	0°
"	"	7	0°	0°
Aug. 13	"	8	0°	0°
"	"	9	0°	0°
"	"	10	0°	0°
"	"	11	0°	0°
"	"	12	0°	0°
"	"	13	0°	0°
"	"	14	0°	0°
"	"	15	0°	0°
Aug. 15	"	16	0°	0°
"	"	17	0°	0°
"	"	18	·5°	0°
"	"	19	·25°	·25°
Aug. 20	"	20	0°	0°

After undergoing the testing as thus described, the core was forwarded to the works of Mr. Henley, North Woolwich, in order to be finished off with a sheathing of spiral iron wire; a process, by the way, which we consider highly injurious to any core of whatever material made.

With respect to the 2000 yards of india-rubber insulated cable submerged at Kurrachee, in India, for the Red Sea Telegraph Company, we can only say that it was not of our own manufacture: but we believe that the makers of that particular wire would now adopt a very different process; not that the failure of this experimental length (made doubtless in the infancy of rubber manipulation), need militate against the question of caoutchouc efficiency in all cases and under all circumstances as an insulator, if due regard be had to its proper application to the wire; if, indeed, all the signal failures which have marked the progress of gutta percha insulation up to this time had been taken note of, and deemed as so many substantial arguments against its use, there would not, at this moment have been a submarine cable in existence, and yet it is an indisputable fact that the history of this material as applied to telegraphy records a maximum of failures.

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The state of the Red Sea cable is adduced as being eminently satisfactory of the efficiency of gutta percha insulation, if this be so, why was not the cable in good working order last spring? and wherefore did it require the personal examination of Mr. Latimer Clark? it being, according to his description, "as perfect both electrically and mechanically as when it quitted the manufactory."

We may ask what constitutes the superiority of gutta percha over india rubber? wherein is it seen? Not surely in the Toulon and Algiers cable, nor yet the Atlantic, nor Mediterranean, nor indeed in any other, since they are all more or less decided failures. One would think it was high time to experimentalize a little on some other material; and what is there better than india rubber according to Mr. Clark's own showing. For is it not a fact that but few of the submarine telegraph companies realise a revenue more than sufficient to pay their expenses and keep their cables in repair, although their tariff is at a high figure?—thus from London to Alexandria we must pay for a message of 20 words 46s. 9d., but from Malta to Alexandria 30s. or 1s. 6d. per word, for 3 words per minute *only*. These enormous charges, and this tardy rate of signalling indicate anything but improvement in telegraphy, and demonstrate pretty clearly the inefficiency of the insulation. And the question may be fairly put, being within the comprehension of all—Would not a cable of low inductive capacity, capable of being signalled through at the rate of 10 or 12 words per minute, be a vast improvement on the gutta percha compound cables now in use? And would not an increase of speed enable a company to lower its charge and thus the public be benefited? And all this, we do not hesitate to say, would be secured by the substitution of india-rubber insulated cables.

We are pleased to find Mr. Clark entertains the same high opinion of india rubber as he had when examined before the Government Committee. But we must take exception to his predilection in favour of it in combination with sulphur. We have specimens of wire covered with vulcanized rubber, which have been immersed in sea water since April, 1860; the vulcanized has become totally rotten, while the pure rubber underneath is in a state of perfect preservation.

We cannot conclude this letter without referring to Mr. L Clark's own words, at p. 330 of the "Government Report on Submarine Cables," wherein he recommends the adoption of pure Para rubber next the conductor. We cordially agree with him, and beg to call to his recollection the experiments on our cable so constructed, November 3, 1862 (a length of the same being still in his possession), and the testing it underwent in his presence at the gutta percha works, proving that our core was 40 per cent. better than the gutta percha specimens, as will be seen from the following statement:—

RESULTS OF TESTING SPECIMEN LENGTHS OF TELEGRAPH CORES BY SIR CHARLES BRIGHT AND MR. LATIMER CLARK, FOR THE INDIAN COUNCIL, NOVEMBER 3, 1862. LENGTH 204 YARDS.

	Diameter of Conductor stranded.	Thickness of the Insulator.	Insulation.	Inductive Discharge.
Hall & Wells.	·135	·1385	Caoutchouc	10°
Silver & Co...	·135	·1385	Caoutchouc	11·6°
Gutta-Percha Company...	·135	·1385	Gutta-percha	14°
Hooper's	·135	·1385	Vulcanized india-rubber	14·1°

It should be understood that these experiments were instituted in order that the Council of India should have practical proof as to which material was the best insulator prior to giving the order for the Persian Gulf cable. The one and the other are fast becoming matters of history. But we must leave it to others to reconcile facts so utterly at variance.

Mr. Latimer Clark founds his principal argument against the adoption of india rubber insulation on a large scale, from the fact of its being, as some would make out, an untried material, and want of practical tests, from length of submersion, &c. We beg to submit, however, that this position is no longer tenable, as must be plain to all who are thoroughly and intimately acquainted with the nature of the material, and whose experience therein furnishes one long practical test of its permanent efficiency for telegraph purposes under any circumstances.—We are, Sir, yours, very respectfully,

Wells and Hall.

Telegraph and India Rubber Works,
Mansfield Street, Southwark, S. E., March 30, 1863.

P.S.—We beg to intimate that if any Government electrician should wish to see specimens of our caoutchouc insulated wires, and at the same time witness their practical efficiency put to the test by actual experiment, in so far as testing the insulation and resistance is concerned, by means of the most delicate and superior instruments, we shall be most happy to be honoured with a visit at our office, any Thursday, between the hours of 12 and 4 P.M.

To the Editor of The Electrician.

Sir,—The degree of merit due to Relay Magnet for *your* turning my attention to the discovery of the element omitted from my theory I leave himself to estimate; and I shall not notice any of the implications in his letter of last week that have not a direct bearing upon the advancement of electrical knowledge, but take the matter up at "the question as it stands." Your correspondent now embodies his arguments against my theory in the following protest. "I say it is impossible practically with the same source of power either to force equal quantities of electricity or water through long depths of wire or pipes as through short lengths of equal calibre." The writer of that protest has had my Definitions at his disposal since the 6th of March (Electrician No. 70.), and therefore could have known what my theory was by appealing to what I *say*, but he has preferred to guess at what I *mean*, and guessed very wide of the mark, as he will perceive if he only examine the quotations I am about to make. With a given power, or given "motive tension—area of conductor—specific conductivity, and intensity," "the quantity of electricity arriving at the end of a conductor in a given time" is inversely, 1st, as the quantity of electricity detained upon it as a charge, and 2dly, as the resistance opposed to the motion of electricity," (Definition 13.) Now the charge and the resistance are larger when the wires are longer (Definition 11), and therefore, as the wires are longer the quantities of electricity passing through them are less.

Relay Magnet cannot do me justice if he will "happen to read words of well known signification as conveying their ordinary meaning" after I have written down that they are being used in another sense. He tells you, Sir, that "your readers are *obliged* to comprehend your contributors' notions from what they say," not intending to take from them the option of remaining without comprehending them if they so select; but I will apply the word "obliged" to the same connection in a compulsory sense, and say that Relay Magnet is bound *so to comprehend*, whether he will or no, or not assume the office of a critic for which, otherwise, he will not have qualified himself.

Your correspondent seems serious, but can he be really so? when he thus says in effect, that a hollow straw will discharge as much water as a sewer, making up in velocity for what it wants in capacity, "in accordance with the principles of hydraulics as given by Hutton, I urge that the mere contraction of the sectional area of a conducting (pipe) would simply cause an increase of velocity in the fluid while passing the contracted portion of the pipe, and not, as stated by Mr. Laming, reduce the (quantity flowing out)." If the physical principles involved in Hutton's hydraulics have been so misunderstood by Relay Magnet, I ought not to be surprised at his miscomprehending those of my electrical theory.

Since the letter to which I am replying was written my extended Definitions have been published, comprehending wires compounded of unequal sectional areas, the additions I have made, however, leave unaffected your correspondent's present argument about "equal calibres," and with respect to unequal calibres his reasoning would, while he is disputing an analogy in hydraulics, extend the same analogy beyond the limit to which it has been already carried. But he will not be able to perceive this until my doctrines have been mastered.

Relay Magnet stigmatizes it as "folly in an exact reasoner to gain a point," to represent it as possible for any one to vitiate conclusions by confounding addition with multiplication, if the end to be answered were sufficiently important, I could point out to him two eminent electricians who have fallen into the inadvertence of confounding the rules in question, one in the pages of this periodical and the other in a work still more exclusively scientific; and I caution him that neither he nor I can be sure of not committing equal blunders.—I am, sir, yours faithfully,

Richard Laming.

To Correspondents.

J. C. Frank.—Silk-covered wires are in reality insulated not alone by the silk but by the air—supposing that air only can obtain access to the wire. For the purpose you have in view—having to guard against the effects of high tension, capable of easily producing a disruptive discharge through air, the wire should certainly be covered with an air-proof material, either in addition to or without the silk. The spermaceti doubtless answers the required purpose to a great extent; but we believe you would incur no great difficulty or expense in having your secondary wire thinly covered with india rubber, or in coating it with gutta percha. Your letter is crowded out from our present impression, but will be inserted next week, as the question may be of interest to others.

James Wilson.—Small spheres of steel may be converted into permanent magnets, by the indnctive action of a current of electricity traversing a flat coil of copper strip placed around the sphere at its circumference; but such a magnet would, we anticipate, be very inefficient. The true polar "surface" being a mere point. We shall be happy to afford any further particulars you may require.

Erratum.—P. 240, 1st column, 4th line from bottom, for "every" substitute "my."

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The Electrician.

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HISTORY, THEORY, AND PRACTICE OF THE ELECTRIC TELEGRAPH. By George P. Prescott. Boston: Ticknor and Fields. London: Trubner and Co.

There is no standard work on the Electric Telegraph in the English language. This is a disgrace to our practical electricians and telegraph engineers. France has her Blavier and her Gavarret; Germany boasts a Schellen and a Steinheil; but the Saxon race possesses no author whose work can be placed on the shelves of our libraries by the side of Faraday, Daniell, or De la Rive. Steam, gas, iron shipbuilding, and all the other great inventions of the present prolific and progressive age possess their standard works of reference and authority. But the most wonderful production of them all, the great civilizer, the destroyer of time, the combiner of nations and peoples in one confederacy of friendship and brotherhood, the solution of the great problem, "Canst thou send lightnings, that they may go, and say unto thee, Here we are?"—the electric telegraph, in regard to the requirements which such a work would supply, remains a blank to the uninitiated, and a puzzle to those thousands who are daily and nocturnally occupied in rendering it available to the million. Is this creditable to our English telegraphists? It is true that we have Highton, a small unobtrusive historical fragment; Lardner, a compiled but well illustrated sketch; and Walker, a short exclusive description of an old-fashioned system, cooped up in the south-east corner of England? America has also produced its Vail, Jones, Turnbull, Shaffner, and the work that we have placed at the head of this article, but all compilations and very far advanced from a standard manual and authoritative class book. That work has yet to be written. How is it that it has not yet appeared? Is it that we have no electrician capable and competent to accomplish such an arduous undertaking? Amongst our telegraph engineers, electricians and contractors, and the officers of our large telegraph companies is there no one able and willing to undertake the task? That they are able to do so we know; no country in the world can produce a finer array of talent and a greater accumulation of knowledge—the hard-earned result of experience and practice. If, then, they are able, are they unwilling? Is want of time their excuse? In his intervals from business, Smiles wrote his "Life of Stephenson;" in his leisure moments Ricardo wrote his works on Political Economy; thus Brougham studied Light, and Mill Philosophy. Are they forbidden from divulging their experience to the outer world? We know that during the Ricardo regime in the old Telegraph Company their officers were strictly prevented from communicating to the public anything they might have acquired, but such ridiculous engrossment of valuable knowledge exploded with its originators' retirement. Moreover it only applied to that Company and did not affect the officers of other establishments or those unattached to any company. Where, then, is the rub? We cannot tell; we can only say that as long as the present vacuity exists in the English literature of practical telegraphy a stain will tarnish the reputation of our telegraphists, the credit that is due to them for the improvements and innovations they have effected in the working of the "wonder-working wire" will be lost to them in posterity; the world at large will continue to retain the very erroneous opinion they hold at present that, in the words of one of our own countrymen, "the English system of telegraphing is the worst managed, the worst constructed, and the worst organized in the world," and, therefore, of course, that English telegraphists are the worst instructed, the most ignorant, and least respected of any nation.

Such is the impression at present, not only amongst foreigners, but amongst our own countrymen, and even of the Government. When the Red Sea cable was to be worked, who were employed in applying instruments and adapting working arrangements? Germans! When the Malta and Alexandria cable was to be tested and examined, who were the electricians engaged? Germans again!! This is very creditable to Messrs. Siemens and Halske, but highly disgraceful to our electricians. The fault is theirs, and not the Government's, theirs for bottling up their experience and not blazoning it forth to the world; theirs for waiting for honour to come to them, and not seeking it boldly in the highways and byways of literature; theirs for letting strangers step in and filch from them their good name, and rob them of that which enriches them very much indeed.

The English system of telegraphs is the most complete and most perfect in the world. It combines efficiency with economy, durability with despatch. It is always ready to undertake any duty for which it is required. It never fails. In the severest storms and fiercest tempests, in the heat of summer and the cold of winter, in rain, fog, or snow, in thunder and lightning, and all the varied phenomena of this changeable climate, it is ever prepared to undertake its allotted task. On that fearful night when the Royal Charter went down on Mona's shore, and the whole face of Europe was swept by that terrible blast, our merry little English poles bent and doubled, some broke, and many fell, but that next evening none could perceive traces of the disastrous gale. How different was it on the continent of Europe? How different is it under similar circumstances in America? Some continental lines remained inactive for days, others for weeks after that memorable night. In America hundreds of miles are blown down in one fell swoop during severe hurricanes. In England gales pass on unheeded. Even now, while penning these lines, one of those violent ebullitions of atmospheric wrath, which have rendered this season a memorable period of disaster and woe, is raging and howling with all the virulence of a tropical tornado. The usually placid stream that flows past the window is lashed into foam. In the distance two stately trees of, perhaps, a hundred years' growth lie grovelling on the ground. Yet the slender poles and their metallic lines that fade away in the distance quiver and tremble, but steadily bear unscathed the raging blast. They are too well selected, too firmly set, and too carefully supported to succumb easily to the stormy elements. It must be a tempest indeed that will lay them low. It is thus with all our engineering works. A thing is not worth doing at all unless it is worth doing well. Permanency, stability, and durability, characterise all our undertakings, and especially our Electric Telegraph; though not economical at the commencement, our capitalists may rest assured that it is the cheapest in the end.

The proverbial humidity and variability of the climate of the British Islands, render them without exception the most difficult spots on the face of the civilized world for the erection of permanent and certain telegraphs. Our fogs and rains make it easier to maintain 1000 miles of telegraph in constant communication in dry climates than 100 miles in our country. In the infancy of the science, when the requirements of insulation were unknown, and a goosequill or small thimble of brown earthenware were considered sufficient to maintain inviolate the communication between two places, a few miles only apart, a shower of rain at once interrupted all further intercourse. A line in South Wales, very recently constructed on the German system, and only 3 or 4 miles in length, suffered similarly. In America, Mr. Prescott says, "Our principal lines work very well during dry weather, when in

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fact scarcely any insulation beyond the dry poles is needed: but let a shower even come up, and all the wires are seriously affected by escape. It is not an unfrequent occurrence, during the rainy season, for all communication between the important cities of New York and Boston by the wires to be suspended, notwithstanding there are no less than eight direct lines extending between the two places." (p. 267) Such a thing in England is never known, except on some old neglected railway wires. From the Land's End to John O' Groat's, from Yarmouth to Milford Haven, with our modern insulating appliances, wires can be erected which fogs cannot affect, nor dampness disturb. What the Yankees call "rain-crosses," or what we term "wet-contacts," are things of the past, and rarely seen. From London to Edinburgh, Manchester, Liverpool, Bristol, and Southampton, daily and hourly telegraphic intercourse is seldom or ever interrupted. Brown earthenware, white porcelain, and ingenious configuration of material have effected this. Ebonite, the new offspring of india rubber, emanating from Silvertown, promises to do even more. Our neglected English electricians have conquered what was considered insurmountable and invincible—the damp and mist of British air.

The telegraph has made greater progress in our little island, than in any other country; and if all its dependencies be included, Canada, India, and Australia, it boasts nearly as many miles of wire as all the rest of the civilized world. One Company alone, the Electric and International, can nearly rival the whole of the United States, and far exceed any European nation. In England the germ was sown. What Cooke originated and Wheatstone schemed, Ricardo introduced, Stephenson fathered, and Clark perfected. The slender wire from Paddington to Slough has spread to a vast network of tens of thousands of miles clasping in its embrace every city of eminence and every town of importance. The Psalmist says—"Their line is gone out through all the earth, and their words to the end of the world." Most appropriate words to be engraved on the marble slabs of the last resting-place of those envied originators of whom it has been said—

> "Seems it not a feat sublime?
> Intellect hath conquered time."

In England alone has the submarine telegraph been fostered. One firm (Newall's) have themselves laid, or constructed, 10,000 miles of wire. Deep-sea cables are, however, up to the present time, a failure; none have prospered; but that spirit of enterprise that no obstacle daunts, that pluck which knows no such word as "fail," that energy which never flags, that ingenuity which surmounts all difficulties, the noble characteristics of the Saxon race, will yet "put a girdle round the earth," and "waft a sigh from Indus to the Pole."

The work before us is a fair sample of its predecessors, a pure compilation, full of errors and defects, and distinguishable chiefly by its absence of original matter. It commences with a free unacknowledged translation from the French, it ends with a similar effusion from the German, which, by the way, for a wonder, is acknowledged. It is replete with piracies from De la Rive and Blavier. It is totally devoid of system or connection. Repetitions abound; it bears the impress of many hands, and a very free use of the scissors. But, with all its defects, the work contains much matter of interest. The chapters devoted to a description of the instruments used in America, are well worth attention. That relating to the House instrument is very clear and explicit, and this is not to be wondered at when our author says:—

"In concluding this chapter upon the House system, we cannot forbear expressing our affection for it, which is like that entertained for an old friend. Indeed, the instrument seems almost human; for its operation is so rapid that we can express our thoughts as freely, and almost as rapidly, as by word of mouth; and then the response comes back to us in an instant, printed in plain Roman letters, our companions in childhood! Altogether, it seems a thing of life, and speaks to us in a language as familiar as household words."

While our cousins across the Atlantic are far behind us in the stability and efficiency of their telegraphs, it must be acknowledged that, in the question of instruments, they are decidedly in advance. The House, Hughes, and Combination instruments, can well be classed among the most exquisite productions of human skill. With a key-board as simple as that of a piano, the most ignorant tyro can convey his thoughts to a friend a thousand miles away in the far distance in clear, bold, legible Roman capitals. Brett and Theiler have essayed this in Europe, but have been unsuccessful. In America alone has the system taken ground.

House's is a miniature condensed air printing machine. Electricity is simply the starting handle. Every throb of electricity transmitted through the wire opens a small valve, like the D valve of the steam engine, allows the condensed air to move a piston which revolves a type wheel, and strikes a letter. One pulsation strikes A, two B, ten J, and twenty-four Z. Let every pulsation have its way and the work is done.

Hughes depends upon the synchronous movement of two type wheels, regulated in the most ingenious manner by springs vibrating with such extreme rapidity that the note of music they murmur in the operator's ear is his criterion of their precision.

The combination system unites the chief excellencies of the Hughes with the minor appliances of the House. "This instrument," Mr. Prescott says, "retains the synchronous movement of the type wheel, the simple form of the press, the frictional movement of the card, the correctors and the detent of the original Hughes invention; but borrows from the House system the double-headed cylinder or plunger, air pump, chamber and valve, and, in addition, contains the electro-magnetic governor invented by Mr. Phelps." It is, in fact, Hughes', a little altered to make it not Hughes'. It prints its characters in ink. Listen to our author.

"Like the House instrument, it has reduced the labour to be performed by the electric current in the lowest possible point; but unlike the House, which requires seven vibrations upon an average for each letter,—or the Morse, which is based upon the number of waves sent, as well as the lengths of time occupied in sending them, and which, upon an average, requires three and a half,—this system requires but one. It had long been considered a desideratum to print a letter at every impulse; but nothing approaching it had ever been obtained until the production of this incomparable instrument by Mr. Hughes."

Further on our author says (p. 142):—

"There is one more point in the splendid achievement of Mr. Hughes which should not be passed over in silence, although of no practical value, and that is his arrangement for working both ways at the same time. This, however, has been accomplished in England by several ingenious electricians, namely, MM. Gintl, Wartmann, Siemens, Halske, and Edling, who have solved the problem of the transmission of two or more despatches over the same wire at the same time by processes entirely different."

He has omitted to notice our English plan for accomplishing the same object by Preece, as novel as it is ingenious, for while every other system requires a compensation current from the same or from separate batteries, this requires but one—the original series of the circuit. The Hughes instrument has not had a fair trial in England. It worked between London and Liverpool; but it is feared that rival interests were too powerful for its favourable reception and examination. Its own intrinsic merits must, however, sooner or later secure its partial adoption. Its general employment is out of the question, for, apart from its delicacy and expense, the Morse system is too deeply rooted and too well adapted for the purposes to which it is applied to be easily supplanted. For long submarine lines Hughes' is, however invaluable, and superior we think to anything yet produced. It is reported to be about to be adopted on a large scale in France. It is also being used by the United Kingdom Company.

A very erroneous impression has obtained credence abroad, is

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even believed at home, and has found an entrance into this work, viz., that the needle system is that most generally employed in England. Nothing is further from the truth. The needle instrument is certainly very extensively employed, and in point of numbers far exceeds the Morse, but all the principal work of the country, all the great commercial intercourse between our chief emporiums of trade, all the domestic and professional communion between towns of consequence are conducted by the printing instrument. The needle instrument is very largely used upon our railways, and for the requirements of that service it is the most admirable system in existence. Morse has been tried and found wanting. The type printing is out of the question. The needle maintains its ground and will do so. It is the cheapest, the simplest, and the least liable to accident of all instruments ever devised for railway telegraphic purposes.

The Morse is very extensively employed in Europe. It has been modified by Siemens of Berlin, and Varley of London, to such an extent that, compared with the American instrument, as described by our author, it is as a river barge to an "outside walkee," as our ocean paddle steamers are designated by the Celestials. The instruments constructed by Siemens and Halske of Berlin are perfect models of workmanship and design. They work with great speed, start and stop themselves, and throw off "yards and yards" of intelligence with no assistance but their own exquisite manipulative mechanism. Digney, of Paris, has made recent improvements which are being extensively employed. The messages are written in ink in place of being impressed on paper, as in the original instrument.

There is very little difference in the comparative speed, when practically employed, of any of these instruments. The limit appears to be the rate a man can comfortably write. Tried experimentally, the Hughes may send its 40 words a minute, but when employed in practice it will soon reach the average usually obtained in the transaction of actual buisness, viz., about 25 per minute. Our author is however remarkably contradictory on this point. He says (p. 114) that the House is "altogether the most rapid, being twice as fast as the Morse and four times as fast as the needle telegraph in use in Great Britain." Now, at page 109, he quotes an authority (Mr. Walker) for placing the speed of the needle at 25 words per minute. According to his estimate, therefore, the Morse would send 50 words and the House 100 words per minute, which is simply preposterous. Good readers frequently have read 40 words per minute on the needle instrument, and the Morse is often worked up to 33, but this is only on special and extraordinary occasions. Neither Hughes nor House can exceed this.

A modification of the Morse is adopted in America which enables the operator to read by sound. The click of the magnet alone conveys the required words. It has the advantage of dispensing with the use of paper and the most expensive part of the apparatus. It also, according to our author, reduces the risk of error, but of the truth of this we must be allowed to be rather sceptical. Mr. Prescott says, "The ear is found much more reliable in comprehending the clicks of the instrument than the eye in deciphering the arbitrary alphabets of dots and lines." Reading by sound is frequently resorted to by our English clerks, and a special instrument has been devised for this purpose by Bright. As an auxiliary system in cases of failure, or injury to the apparatus, it is advisable to encourage such a practice, but we must hesitate in recommending the permanent adoption of what is but an evanescent signal, until more reliable information can be obtained of its reported superiority over the recording contrivance.

The Bain's and Dial instruments, though freely described by our author, demand but a fleeting notice, as their use is very circumscribed. Wheatstone has, however, lately introduced a beautiful modification of his dial instrument which bids fair to secure considerable attention. A small brass case, similar in size to those containing those cheap Parisian clocks with which our shop windows are filled, is provided with a face or dial, around the margin of which the letters of the alphabet and numerals are placed. A light hand speeds swiftly over these characters, and on the depression of a particular key at any distant place, stops significantly at the letter it is required to point out. Any child can work it. No tuition is required to decipher its meaning. The day will come when telegraphs will be employed for our domestic purposes between the drawing-room and servants' hall, between the home and the office, the house and the stable, and no instrument has yet been introduced which, for simplicity, efficiency, and aptitude, can surpass this elegant machine. Several manufacturers have endeavoured to turn out a similar instrument, but none have equalled Wheatstone's in certainty of action and beauty of mechanism.

Subterranean and submarine telegraphs are but little known in America. Their only submarine cable lies between "Nantucket" and "Tukernuck," "Muskeget" and "Chappaguidie" across the "Swimming ground," between "Nobsque" and "West Chop," and between two or three other euphonious spots—in all about thirteen miles.

The oft-told tale of the celebrated Atlantic cable, that grand experiment and wretched failure, receives its full meed of narration and criticism. Every word and message sent through the cable, "four hundred hard, solid facts for the digestion of those who still contend that no message was ever received through the Atlantic telegraph cable," are given verbatim. Our cousins seem to share the opinion generally prevalent here, that the failure of the Atlantic cable is not to be attributed to any inherent defect in the cable itself, but to the villanous manner in which it was abused by those who were appointed to nurse and foster the most marvellous enterprise of modern times.

There is scarcely a railway in England which does not possess its telegraph. It is used very extensively as an auxiliary for facilitating the passage of trains. On some single, and our busiest double lines, the movement of trains is entirely regulated by it. Confined in his office, at, perhaps, the farthest limit of his line, the superintendent is made acquainted with the movement and position of every train on the road. He shunts one train here, stops another there, pushes on a third at one place, allows a fourth to pursue, uninterrupted, the noisy tenor of its way, works all into that system and punctuality which is the soul of business and the characteristic of our railway system. The lives of all the passengers are in his hand, and yet nothing is left to chance. No accident can occur; the only effect of failure in telegraphing is delay; except in such circumstances as when a stupid officer in a recent accident, himself inserted a word in a message, which altered its whole purport and produced a frightful collision.

In America, railway telegraphs, seem to be but a recent adoption. Still they appear to be extensively used, and "the engineers and conductors now actually feel safer and more secure while moving under telegraphic orders, than when following their printed instructions."

Many of our principal English railways, possessing two or more sets of rails, are divided into certain distances, at which point "train signalling instruments" are erected. Each length and each set of rails is protected by its own telegraph instrument, the face or index of which indicates the state of that length of line; whether "clear" or "blocked." The best and most suitable instrument for this purpose is, we think, that of Preece, who has produced an instrument not only less liable to derangement from atmospheric influences (a considerable desideratum), but has so assimilated it, both in form and system, to the signals in use out of doors, that any person acquainted with the management of the railway signals is at once master of this simple and efficient instrument.

It is curious to observe how fond the Americans are of introducing novel technical expressions, peculiar to themselves, to denote things and points well known and long received in use here, thus a submarine cable is "subaqueous;" a contact is "a

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cross;" "cells" are "cups;" what we express by saying to "put on earth;" they say "to lay on a ground;" our "line men" are with them "repairers;" "a fault" is "an escape;" "lightning conductors" are "lightning arresters;" "clerks" are "operators;" and so on. It is the same with railways, our "line" is there "track;" our "carriages" are "cars;" "guards"—"conductors," &c., &c.,

The telegraph has been applied to a most important and useful purpose in America, which has not yet received adoption in England. This is the telegraphic fire-alarm. From the central station at the Boston Fire Engine Department, wires radiate to every quarter of the city. Upon these wires signal boxes of the simplest character are fixed, which can be brought into operation by any one, by the simple revolution of a handle. Each box contains a little signal bell which can be rung from the central station. Throughout the city heavy fire bells are fixed, connected with striking machines, similar in character to the striking machinery of a clock, but liberated by electricity.

The city is divided into five districts and each district into ten stations. Each station has its particular call. If a fire takes place in district 3, station 5, the signal box of that station is operated upon and instantly the central station is aware that a fire rages near station 5, district 3. The central station instantly sounds the alarm bells throughout the city, and rings the little signal box bells. Every bell booms forth through the stillness of the night or the busy hours of day the district No. 3 and every box sounds the station No. 5. The fireman listens to the public alarm bells, and obtains from them the number of the station; he runs to the nearest signal box and listens a moment to gather the station number from its little signal bell and he thus knows that the fire is at district 3, station 5. This is all done by only five wires. It has been in operation eight years. "As soon as the bells strike groups of persons will be seen clustering around each signal box to listen to the tapping of the station number, and it is soon known to the whole fire department exactly where the alarm originated."

Our author says (p. 244):—

"The whole number of alarms and the proportion of false alarms have been greatly diminished by the system. Science can make no contribution to civilization without the requisite social conditions. The trust of the fire-telegraph system, in this case, was placed in the hands of the citizens, and it has yielded to them its fruits without abuse. This may deserve to be chronicled as an instance of well-rewarded confidence in the sobriety and capacity for self-government of the American people. The signal boxes, which are the sensative extremities of the system, may be protected by various methods, according to social requirements. In Boston it has been guarded best by putting it in the most public place, and exposing it to the fullest light.

"The mechanism of the fire telegraph is arranged and disposed for the purpose of preserving the wealth, the fruit of human industry and nature's bounty from destruction. It therefore accomplishes an end of human use; but more than this, it is a higher system of municipal organization than any which has heretofore been proposed or adopted. In it the New World has taken a step in the forms of civilization in advance of the Old."

Uniform time is also signalled throughout the whole city by these bells.

It is a source of gratulation to us in England that fires are with us matters of rarity compared with what they suffer in America. In Boston alone for eight years they averaged 163 per annum.

There is another purpose of vast national importance to which the telegraph has been applied in America, and which has very recently been introduced into this country, and that is in centralizing meteorological observations simultaneously made at different places along the whole of the seaboard of the country for the purpose of forewarning the approach of storms. It has, however, only been adopted by private firms and individuals in the United States. In England, the Government have taken the matter up in a very praiseworthy and satisfactory manner. The Meteorological Department of the Board of Trade, under the able superintendence of Admiral Fitzroy, have, in conjunction with the telegraph companies of England, established various points of observation all around our coasts, from whence, every morning, reports are transmitted to Whitehall. The information they impart is to be seen every morning prominently placed in the columns of our leading daily journals. A system of signals is about to be used at all our coast-guard stations which will acquaint all passing ships of the probable approach of danger. The advantage of such a system to our coasting trade is incalculable. The approach of a storm from any quarter is almost invariably heralded several hours in advance by the behaviour of the barometer. The law of storms is so well known that when once a storm commences at any spot its course can pretty well be calculated. Acquainted with the necessary facts by telegraph and acting upon these known laws, the Meteorological Department will instruct all the coast-guard stations to show that signal which the approaching storm demands. Thus ships can make for the open sea or run to the nearest port and escape the coming danger.

There are numerous other purposes of immense consequence and vast importance to which the telegraph is applied which cannot receive full justice in a short notice of this description, chief among which must be enumerated a system for announcing the arrival of homeward-bound ships off certain points and headlands—a system in full adaption at Southampton, Liverpool, and Gloucester, and about to be generally introduced all around our coasts.

It has also been adapted for the steerage of ships, and indeed it is impossible to say to what purpose domestic, commercial, and imperial, the "wonder-working" wire could not be applied.

CHEMICAL PROCESSES FOR SILVERING GLASS AND PORCELAIN.

Ordinary looking-glasses, as most persons are aware, are "silvered" with an amalgam of tin formed by bringing mercury into contact with tin foil laid upon the surface of the glass, and removing excess of mercury by pressure. It is not so generally known that several processes, incomparably superior in their results to the above, have within a few years been devised for depositing upon glass a brilliant and unalterable coating of pure silver. Unfortunately, the apathy or ignorance of the public has been sufficient to discourage the very general application of these new methods; for, in spite of the beauty and extreme durability of the really *silvered* glasses, a slight difference of price in favour of the amalgam-coated ones has ensured to the latter a decided preference. The art of coating glass or porcelain with a deposit of pure metal is not only of great interest in a chemical point of view, but may often be of advantage in the applications of electro-metallurgy. The thinnest film of silver upon the surface of the above-mentioned non-conducting materials of course renders it possible to obtain, by the voltaic battery, a deposition of metal which may answer a useful or an ornamental purpose. Thus, we may mention, we have been enabled to cover with a thick deposit of copper those portions of glass retorts and matrasses which, for certain purposes in the laboratory, are often exposed to a high degree of heat. For articles of *luxe*, the combination of metal work with glass or porcelain —often productive of very beautiful effect—might be greatly facilitated and extended by means of the processes to which we refer.

It was first observed by Liebig that, by the reaction of aldehyde upon a neutral or ammoniacal solution of silver, the metal became precipitated upon the interior surface of the glass vessel containing the solution, or upon any object of glass or porcelain immersed in the fluid. The effect of the reaction is evidently to render the attraction

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of the glass for the molecules of silver contained in the fluid greater than that of the other constituents of the latter for these molecules. At a later period this chemist published the following method, in which aldehyde is replaced by sugar of milk.

Ten *grammes* of fused nitrate of silver are dissolved in 200 cubic *centimètres* of water, and solution of ammonia is added until the fluid becomes limpid. To this solution is added 450 cubic *centimètres* of a solution of caustic soda, free from chlorides, of the specific gravity of 1·035. The precipitate obtained is redissolved in caustic ammonia. To obtain a complete saturation, fresh nitrate of silver is added until a grey precipitate begins to fall, and the saturated solution is then diluted with water until it occupies a volume of 1·500 cubic *centimètres*.

Immediately before use, this fluid is mixed with one-sixth to one-eighth of its volume of a solution of one part of sugar of milk in ten parts of water. The silvering vessel should be symmetrical in form with the surface to be silvered, so as to preserve everywhere the same thickness of fluid, viz.: 1½ to 1¾ *centimètres*. The object to be silvered may be supported at its extremities upon small cones. Its surface must be carefully cleaned and finally washed with alcohol, and the fluid must be in contact with it at every point where silver is to be deposited. The object of preserving a certain limited thickness of fluid at every point is to prevent the deposition of an excess of silver, which gives a dead instead of a brilliant lustre.

The reduction takes place at ordinary temperatures after the addition of the sugar of milk.

The glass at first becomes blackened, but soon takes the appearance of a mirror. The operation is ended when the surface of the fluid between the silvering vessel and the object to be silvered has become covered with a brilliant pellicle of reduced silver. The silvered surface should be well washed, without touching, and dried in a warm atmosphere. The film of silver, when dry, adheres strongly, and may even be polished with fine plate powder upon velvet. It is advisable to cover it with a varnish of gum dammar and alcohol, very fluid and transparent, before framing. The quantity of silver deposited upon one square mètre of surface is about 2·3 *grammes* only, and is but about the twenty-third part of the total quantity precipitated from solution, the remainder being found in the silvering vessel.*

Here the silvering fluid is simply a dilute solution of oxide of silver in ammonia, mixed with a reducing agent, viz., sugar of milk. The proportions given are those that experience has found to give a good result; but we have found it by no means absolutely necessary to adhere to them strictly.

In the process patented in England by Mr. Drayton, an alcoholic solution of the volatile oils of cassia, cloves, &c., is employed as a reducing agent, with an ammoniacal solution of nitrate of silver. It has been stated that the use of these volatile oils has not been attended with favourable results; brownish stains being sometimes produced in the deposited silver, owing to the precipitation with the metal of small quantities of resinous matter formed by the oxydation of the vegetable essences.

Mr. J. Lowe employs a solution of glucose or grape sugar, in combination with lime, as the reducing agent. The following gives the details of this method, which is said to have proved very satisfactory:—

In a solution of 50 parts of glucose in 5000 parts distilled water, dissolve 20 parts of pure quick lime; filter out of contact with air, and preserve the clear fluid in well stoppered bottles. This forms the reducing solution. The silver solution is made by dissolving 7 parts of fused nitrate of silver in 150 to 160 parts of water; ammonia being afterwards added until the precipitate, which is at first formed, becomes redissolved. Immediately before use, 1 volume of the silver solution is mixed with 6 volumes of the sugar-lime solution. The surface of the glass should first be wetted with the silver solution; and, during the operation of silvering, the vessel containing the fluid should be gently rotated to prevent the deposition of the greater portion of the silver at the bottom of the vase. The interior surface of vessels especially, may, by this means, be covered with a brilliant and solid coating of silver.

The process of Mr. L. Hill is similar to the above; one part by weight of the fused nitrate of silver is dissolved in two parts of water, and a sufficient quantity of the solution of ammonia is added to give a clear fluid. To this is added sixty-two parts of water, holding in solution one part of glucose and a small quantity of mannite, and mixed with one-fourth part of ether. The glass is immersed in the fluid, which is then heated in the water bath, and kept in motion until the operation is concluded. It is recommended to obtain the glucose by treating cane sugar with dilute sulphuric acid at the temperature of 158° Fahrenheit, saturating the fluid with carbonate of lime, filtering, evaporating, and decolorising by means of animal charcoal.

MM. Delamotte and Pron de la Maisonfort have proposed as reducing agents certain bodies which they consider as formed by the substitution of nitrous acid for hydrogen in organic bodies, such as pyroxyline, nitro-mannite, and nitro-picric acid. They also heat the compound fluid to about 150° Fahrenheit. It is questionable whether the silver precipitated by this means would be sufficiently free from organic substances of the nature of resin or ulmic acid.

In the process of M. Petitjean, of which a description has been given by Prof. Faraday,* the reducing agent is tartaric acid, which, in small proportion, is added to a dilute ammoniacal solution of the nitrate of silver. This system has been successfully applied at the manufactory of M. Brossette, in Paris.

We have now to advert to the recent important researches of MM. Millon and Comaille on the mutual reaction of the proto-salts of copper and the salts of silver. When an ammoniacal solution of protochloride of copper is added to an ammoniacal solution of the nitrate of silver, the latter metal is precipitated in an amorphous form, and in an extremely minute state of division. The metallic powder thus obtained adheres, when dry, to everything it touches, can be readily spread so as to form a continuous surface, and, by the action of the burnisher, acquires a brilliant polish. It is sufficiently evident that this impalpable powder of pure silver is susceptible of many important uses, and we may specially recommend it to our electro-metallurgical readers as affording perhaps the readiest means of giving a conducting surface to non-conducting and polished materials to be partly or wholly covered with a thicker coating of metal by the action of the battery. With it, also, a plate of glass may be readily converted into a brilliant mirror, reflecting light far more perfectly, as M. Steinheil has shown, than the amalgam-coated glasses of commerce. On a future occasion we shall show that imperfectly conducting materials, such as silk or linen, may, as well as glass and porcelain, be "electro-plated" by means similar to those above described.

* *Journ. fur. pract. Chem.* t. lxviii. p. 316.

SUBMARINE TELEGRAPHY AND THE RETARDATION OF SIGNALS.

(Continued from p. 253.)

"Chairman (to Mr. Whitehouse): Supposing the Atlantic cable was made with a conductor a foot in diameter?—First, I believe it to be practically impossible to insulate a submarine conductor of such magnitude; and secondly, if made, I believe that such a cable would consume, by its enormous surface for induction, any amount of current which could be thrown into it from an ordinary battery during rapid signalling. Clearly it would convey a continuous current with a facility strictly proportional to its sectional curve and conductivity, but for rapid signalling I think it would prove a failure.

"For theoretical consideration do you think you would increase the speed materially by such an increase of the conductor?—I think you would have to increase your battery power to a fearful extent, in order to allow for the great loss produced by surface induction.

"In intensity?—Chiefly, but not solely, in quantity; unless you did that you would have an absolute loss of working speed.

"You have stated that you had requested to be allowed to make certain experiments before you should be asked to pronounce upon the core of the Atlantic telegraph; will you explain the circumstances which prevented those experiments being tried?—Chiefly the lapse of time; I was then speaking to Mr. Cyrus Field, who was the most active man in the enterprise, and he had so much steam that he could not wait so long as three months, he said, 'Pooh, nonsense, why the whole thing will be stopped, the scheme will be put back a twelvemonth, cannot you say now that you know that will do?' I said, 'But I cannot at all tell you that that is the best; I think that we are bound to find out what is the best before we go into it.' It was then determined that if I took the three months it would lose the year; he then pressed me about it and he said, 'We hope that you are not going

* Poggendorff. Ann de Phys, vol. ci. p. 313.

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to stop the ship in this way,' I had pretty nearly determined that I would not give an opinion, but he extorted the opinion that I was quite willing to say 'that it could be done with that,' but I was determined to withhold anything like an official opinion till I had made the experiments; I had got the permission of two companies who had underground wires of different sizes running between the same towns to experiment during the night, and I could have seen the different ratio of retardation upon those two lengths of wire in similar circumstances, when I should be better qualified to give an opinion.

"Mr. Saward: Do you imagine that that joint was made at the gutta percha works?—It was a false joint; a thing made to save trouble after the first covering with gutta percha, and the lazy rascal just patched it together before it went through the second covering, there was no real joint made. The gutta percha went over it, and then it went through a second covering, and it was not discovered till it gave out in this way in the tank. I said, 'If any careless rascal has done that once, he may have done it again; what are we to do?' There was a length of several hundred miles lying at the gutta percha works already completed when I detected this flaw. I said, 'I have no confidence in that, unless it is tested?' They said, 'How is it to be tested?' It was evident that it was no use testing it by the ordinary test for continuity, and I desired it to be tested with a strain, so as to draw these ends asunder. I said. 'We must put the whole of this under just strain enough to detect if there is a breach of continuity.'

"Chairman: Was it done?—Yes.

"Mr. Saward: What was the strain put upon it?—I tried a great many experiments to determine how much strain would show these bad joints without producing the least permanent stretch. Of course we could not produce any permanent stretch without injury. I tried to determine by the friction-brake, or some arrangement of that sort, how much strain could be put on to detect any break of continuity that occurred.

"Did you detect any other flaws?—Yes, we had a second.

"Mr. Varley: Do you remember how much strain you put upon it?—It was estimated at about forty pounds. Yet, although you know how many pounds' weight you put upon the friction-brake, but you cannot always tell what strain that gives; there is a source of accident you could not determine, and could not avoid. During the process of winding under strain (it could not be wound by hand, it was wound by steam) there was a large drum and a swift, from which the core was to run, when the drum began to be filled with the core, the circumference was small, and the winding took place slowly, and the core came easily off the swift; but as the drum filled, and its circumference got larger, each revolution then took off nearly three times as much from the swift as it would before; as you came to the small part of the swift, the velocity of rotation increased rapidly, and the speed of the swift was about as much as four times what it was at the beginning, so that the friction varied; we had to stop sometimes because the swift would be overrun, and there would be jerks, and the inertia then would give the core a stretch, so that it was subjected to a trial that really I should be very sorry to subject a cable to again.

"Did you try any experiments with the Atlantic cable to see the speed at different lengths?—Yes, and they corresponded very nearly with those I had made out before at Messrs. Glass and Elliott's, they are as nearly identical as possible. The retardation is very nearly in the simple ratio as the distance, not as the square of the distance, and the working speed bears a strict relation to the amount of retardation."

Professor Hughes, a gentleman who has given much attention to Submarine Telegraphy, after expressing his entire disagreement with Mr. Whitehouse as to the advantage of small conductors, states in his evidence, "I find that in practice that I get more speed through a large conductor than I do through a small one; through the same length, in fact, there is a very great difference when we change the observing instrument or with different sized conductors."

In answer to the question "What is the law of the increase of speed which you have discovered?" the Professor replies, "I can give you the result and the number of speeds that I got through different lengths of cable; for instance, with the Atlantic cable, of a length of 2,500 miles, I could only get 20 waves or 40 currents in a minute, the size of that conductor was a 14 wire. With the Tasmanian cable, of a length of 240 miles, I could get 150 waves a minute, the size of that wire was 16, it was one solid wire. With the Red Sea cable, of a length of 1,700 knots, nearly 2,000 miles, I could get 30 waves, the size of the wire was No. 11; through 1,000 miles of the same cable I could get 50, and through 500 miles I could get 120 in a minute. Through the Denmark cable, with a No. 16 wire, 300 miles in length, I could get 110 waves; but in the Atlantic cable I used the induction coil apparatus to get this high speed, with the Red Sea cable I used Daniell's battery. These were practical results counted in the transmission of messages; counting mere reversals, I could receive one-third more; the 20 waves through the Atlantic was arrived at only by using a sensitive relay, whilst the Red Sea was worked same distance easily without relay."

It will be seen from Professor Hughes' statement that in every instance the retardation is as to the length and not as the square of the length, so far coinciding with Mr. Whitehouse's second statement.

The following table will show the result in a clearer form:

Description of Cable.	Length in Miles.	Size of Wire.	No. of Waves per Minute.
Atlantic cable	2,500	No. 14	20
Danish cable	300	„ 16	110
Tasmanian cable	240	„ 16	150
Red Sea cable	2,000	„ 11	30
do. do.	1,000	„ 11	50
do. do.	500	„ 11	120

The number of waves obtained on the Atlantic cable very nearly corresponds with the number obtained on the Danish and Tasmanian cables—the difference being caused by the inequality in the size of the conductor and the thickness of the insulator. The Red Sea cable's retardation is nearly in a direct ratio to its length. Had the law of the squares held good, the number of waves obtainable on the 2000 miles of the Red Sea cable would not have exceeded eight in number per minute.

To proceed with Professor Hughes' evidence, Mr. Varley puts the following important questions:—

"Have you found that as you increased your speed so your deflection decreased in the same proportion; if you increased your speed from a reversal of once per second to a reversal of two per second then your deflection at the other end varied from sixty degrees to about thirty degrees; do not you find them respond in a corresponding degree?—I am not prepared to state just now the exact scale.

"You are aware of Professor Thompson's experiments, that a current is found to arrive in a line which would describe a curve; from your statement your experiments seem to make it appear that it does not arrive in a curved line but in a straight line?—I believe it to be practically a straight line.

"The current goes on continually progressing in a straight line?—Yes, from infinitely nothing up to the degree you wish to get at.

"There is a certain period at which it will arrive at its maximum, and that is the end of it?—Yes; practically.

"You are aware that that does not apply with Professor Thompson?—I believe so.

"He states, upon the result of his experience, that it will take an eternity of time to charge a cable, and consequently it will take an eternity of time before you can approach to the maximum curve at the distant end?—I believe that the charge of the cable is in proportion to the resistance of the wire.

"You believe that in a given period the cable will arrive at its maximum charge?—Yes, according to the resistance of the wire, to prove that, if we have a galvanometer at the other end, the first instant we touch the battery we see nothing, the next instant the needle will commence moving from 2 to 6 up to 60, and will never go any more; it will stay there as long as we have the same current. You do not see any curve in the movement of the needle, the needle goes gradually up.

"You say that it will work continually up, and then must come to a dead stop; have you found it to do so?—Yes, it does.

"You have stated that in the Atlantic cable, 2,500 miles, you got 20 waves per minute, was that 20 positive and 20 negative?—Yes.

"Mr. Whitehouse has stated that he got 120 a minute?—Yes, I heard him state so; he stated so to me, that he had got that number, and I asked him to show it to me, but the most he could get was 20.

"With the Red Sea cable you only got 30 waves, that was 2,000 miles, though its conductor was very much larger, do you attribute the low speed to the fact that you used the battery current instead of the induction current?—Yes; but I worked this distance easily without relay, which could not be done with the same magnet on the Atlantic, either with coils or battery."

(*To be continued.*)

A STORM IN THE TROPICS.

The distance between Barbadoes and St. Vincent is nearly 80 miles. This storm began at Barbadoes a little before midnight on August 10, 1831; but it did not reach St. Vincent until 7 o'clock next morning; its rate of progress, therefore, was about ten miles an hour.

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A gentleman who had resided for forty years in St. Vincent, had ridden out at daylight, and was about a mile from his house, when he observed a cloud to the N. of him, so threatening in appearance, that he had never seen any one so alarming during his long residence in the tropics; and he described it as appearing of an olive-green colour. In expectation of terrific weather, he hastened home to nail up his doors and windows; and to this precaution attributed the safety of his house.

The centre of this hurricane, coming from the eastward, seems to have passed a little to the N. of Barbadoes and St. Vincent; and Mr. Redfield has traced its course to the southern United States of America.

On August 10, 1831, the sun rose without a cloud, and shone resplendently. At 10 A.M. a gentle breeze which had been blowing died away. After a temporary calm, high winds sprung up from the ENE., which in their turn subsided. For the most part calms prevailed, interrupted by occasional sudden puffs from between the N. and NE.

At noon the heat increased to 87°, and at 2 P.M. to 88°, at which time the weather was uncommonly sultry and oppressive.

At four the thermometer sunk again to 86°. At 5 the clouds seemed gathering densely from the N., the wind commencing to blow freshly from that point; then a shower of rain fell, followed by a sudden stillness; but there was a dismal blackness all around. Toward the zenith there was an obscure circle of imperfect light, subtending about 35° or 40°

From 6 to 7 the weather was fair, and wind moderate, with occasional slight puffs from the N.; the lower and principal stratum of clouds passing fleetly toward the S., the higher strata mere scud, rapidly flying to various points.

At 7 the sky was clear and the air calm: tranquillity reigned until a little after 9, when the wind again blew from the N.

At 9.30 it freshened, and moderate showers of rain fell at intervals for the next hour.

Distant lightning was observed at 10.30 in the NE. and NW. Squalls of wind and rain from the NNE. with intermediate calms succeeding each other until midnight. The thermometer meantime varied with remarkable activity; during the calms it rose as high as 86°, and at other times it fluctuated from 83° to 85°. It is necessary to be thus explanatory, for the time the storm commenced and the manner of its approach varied considerably in different situations. Some houses were actually levelled to the earth, when the residents of others, scarcely a mile apart, were not sensible that the weather was unusually boisterous.

After midnight the continued flashing of the lightning was awfully grand, and a gale blew fiercely from the N. and NE.; but at 1 A.M. on August 11, the tempestuous rage of the wind increased, the storm which at one time blew from the NE. suddenly shifted from that quarter, and burst from the NW. *and intermediate points.* The upper regions were from this time illuminated by incessant lightning; but the quivering sheet of blaze was surpassed in brilliancy by the darts of electric fire which were exploded in every direction. At a little after 2 the astounding roar of the hurricane, which rushed from the NNW. and and NW., cannot be described by language. About 3 the wind occasionally abated, but intervening gusts proceeded from the SW., the W., and WNW., with accumulated fury.

When the lightning also ceased, for a few moments only at a time, the blackness in which the town was enveloped was inexpressibly awful. Fiery meteors were presently seen falling from the heavens; one in particular, of a globular form, and a deep red hue, was specially observed to descend perpendicularly from a vast height. It evidently fell by its specific gravity, and was not shot or propelled by any extraneous force. On approaching the earth with accelerated motion, it assumed a dazzling whiteness and an elongated form, and dashing to the ground, it splashed around in the same manner as melted metal would have done, and became instantly extinct. In shape and size it appeared much like a common barrel-shade;* while its brilliancy and the spattering of its particles on meeting the earth, gave it the resemblance of a body of quicksilver of equal bulk. A few minutes after the appearance of this phenomenon, the deafening noise of the wind sank to a solemn murmur, or more correctly expressed, a distant roar; and the lightning which from midnight had flashed and darted forkly with few and but momentary intermissions, now, for a space of nearly half a minute, played frightfully between the clouds and the earth with novel and surprising action. The vast body of vapour appeared to touch the houses, and issued downward flaming blazes, which were nimbly returned *from the earth upward.*

The moment after this singular alternation of lightning, the hurricane again burst from the western points with violence prodigious beyond description, hurling before it thousands of missiles—the fragments of every unsheltered structure of human art. The strongest houses were caused to vibrate to their foundations, and the surface of the very earth trembled as the destroyer raged over it. No thunder was at any time distinctly heard. The horrible roar and yelling of the wind, the noise of the ocean—whose frightful waves threatened the town with the destruction of all that the other elements might spare—the clattering of tiles, the falling of roofs and walls, and the combination of a thousand other sounds, formed a hideous and appalling din. No adequate idea of the sensations which then distracted and confounded the faculties, can possibly be conveyed to those who were distant from the scene of terror.

After 5 o'clock, during short moments (the storm now and then abating) the falling of tiles and building materials, *which by the last sweep had probably been carried to a lofty height*, became clearly audible.

At 6 A.M. the wind was at S., and at 7 SE.: at 8 ESE., and at 9 there was again clear weather.

* * * * * * *

As soon as dawn rendered outward objects visible, the narrator, anxious to ascertain the situation of the shipping, proceeded, but with difficulty to the wharf. The rain at the time was driven with such force as to injure the skin, and was so thick as to prevent a view of any object much beyond the head of the pier. The prospect was majestic beyond description. The gigantic waves rolling onward, seemed as if they would defy all obstruction; yet as they broke over the careenage, they seemed to be lost, the surface of it being entirely covered with floating wreck of every description. It was an undulating body of lumber *—shingles, staves, barrels, trusses of hay, and every kind of merchandize of a buoyant nature. Two vessels only were afloat within the pier; but numbers could be seen which had been capsized, or thrown on their beam ends in shallow water.

On reaching the summit of the cathedral tower, to whichever point of the compass the eye was directed, a grand but distressing picture of ruin presented itself. The whole face of the country was laid waste; no sign of vegetation was apparent, except here and there small patches of a sickly green. The surface of the ground appeared as if fire had run through the land, scorching and burning up the productions of the earth. The few remaining trees, stripped of their boughs and foliage, wore a cold and wintry aspect; and the numerous seats in the environs of Bridgetown, formerly concealed amid thick groves, were now exposed and in ruins.—*The Weather Book, by Admiral Fitzroy.*

* The glass cylinder round candles in the tropics.

A SENSITIVE THERMOMETER.

At a meeting of the Manchester Literary and Philosophical Society on the 11th ult., Dr. Joule made the following communication respecting a new and extremely sensitive thermometer:—"Some years ago I remarked the disturbing influence of currents of air on finely suspended magnetic needles, and suggested that it might be made use of as a delicate test of temperature. I have lately carried out the idea into practice, and have obtained results beyond my expectation. A glass vessel in the shape of a tube, two feet long, and four inches in diameter was divided longtitudinally by a blackened pasteboard diaphragm, leaving spaces at the top and bottom, each a little over one inch. In the top space a bit of magnetised sewing needle, furnished with a glass index, is suspended by a single filament of silk. It is evident that the arrangement is similar to that of a "bratticed" coal-pit shaft, and that the slightest excess of temperature on one side over that on the other must occasion a circulation of air which will ascend on the heated side, and, after passing along the fine glass index descend on the other side. It is also evident that the sensibility of the instrument may be increased to any required extent by diminishing the directive force of the magnetic needle. I purpose to make several improvements in my present instrument, but in its present condition the heat radiated by a small pan containing a pint of water heated 30°, is quite perceptible at a distance of three yards. A further proof of the extreme sensibility of the instrument is obtained from the fact that it is able to detect the heat radiated by the moon. A beam of moonlight was admitted through a slit in the shutter. As the moon (nearly full) travelled from left to right the beam passed gradually across the instrument, causing the index to be deflected several degrees, first to the left and then to the right. The effect showed, according to a very rough estimate, that the air in the instrument must have been heated by the moon's rays a few ten-thousandths of a degree, or by a quantity no doubt the equivalent of the light absorbed by the blackened surface on which the rays fell." (A few months ago, Professor Tyndal, the popular lecturer at the Royal Institution, London, described experiments which he had made, and which he alleged proved that the moon radiated cold, instead of heat. Dr. Joule's new and sensitive instrument appears to negative, in the most direct manner, the Professor's conclusion.)

* The American term for timber. *Shingles* are made of split blocks of wood, and are used instead of tiles or slates for roofs.

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LONDON GALVANIC HOSPITAL.

[We have much pleasure in bringing to the knowledge of our readers the existence and objects of this beneficent Institution, which, during the short period which has elapsed since its foundation, has done much to forward one of the most important applications of electrical science, to alleviate suffering, and to remove disease, among the poorer classes especially, who stand most in need of such endeavours.]

Diseases Especially Treated at the Hospital.

A large class termed Neuralgiæ, in which the Nerves although not actually diseased, still are so deranged in their healthy functions, as to "cry out" with pain. These are usually rapidly relieved and cured by Galvanism, and may be enumerated as Neuralgiæ, Ticdoloreux, Lumbago, Sciatica, Stitches, and other similar pains.

Another large class—Rheumatic Affections—rapidly yield to the scientific application of Galvanism, particularly where the muscular system is affected.

In Rheumatic Paralysis Galvanism is all powerful, and the limb is quickly restored; indeed, Paralysis of this class is frequently cured in one month's treatment.

Paralysis arising from injury to the Brain or Spinal Cord, when the acute stage has been passed through safely, yields steadily and slowly to Galvanic treatment. A few months must be given up to regular administrations, otherwise, in these cases, a cure cannot be anticipated; but, if the sufferer use patience, great relief, if not an actual cure, can invariably be depended upon. The diseases of this class may be termed, Hemiplegia, Paraplegia, General Paralysis, Softening of the Brain, &c., &c.

Paralysis in Children during Teething, are truly hopeful cases, and may be said to be, in nearly every instance, quite curable by Galvanic action.

Muscular Distortions, Spinal Curvature &c., frequently occur during Teething, and grow gradually worse. Here Galvanism is applied with extraordinary effect.

Spinal Curvature in growing Children is best treated by Galvanism.

Affections of the Genito-Urinary System, in both sexes, and the various concomitant disorders usually arising from these conditions, are particularly adapted for treatment by Galvanism, combined with other restoratives. Long since, Galvanism alone has been declared, by one of our most esteemed authorities, as the only *true* emmenagogue, but it must be judiciously applied.

Certain forms of Nervous Deafness, Amaurosis (Blindness), Senile Gangrene, Spinal Irritation, Glandular Enlargements, Torpid Ulcers, Hysteria, and other affections which cannot be detailed here, are more or less curable by Galvanism with other treatment pursued at the Hospital.

First Annual Report. (July 1862).

Twelve months having passed since the London Galvanic Hospital has been established, it is my pleasure as well as duty to lay before you the report of the success of this novel Institution. The London Galvanic Hospital is the first, and, at present, the only Institution in the world founded expressly for the treatment of disease with the aid of galvanism; and although an immense mass of facts have been already collected to prove that in a certain class of cases galvanism holds out the only chance the sufferer has of obtaining relief; still, no institution had been set aside for such a purpose.

The Hospital was opened for out-patients on the 1st of July, 1861, and the expenses, up to the present date, have been paid by means of the subscriptions of those who originally came forward to found so much required an institution. The Hospital enters its second year entirely free from debt, and it depends upon the liberality of those to whom this is addressed, whether the inestimable benefits which have hitherto only been extended to out-patients shall be granted to the bed-ridden.

The Hospital has been formed to carry out three principal objects; firstly—"to extend to those, *the severity of whose maladies remain intractable to ordinary treatment and medicines*, a further opportunity of obtaining relief and ultimate cure by galvanic agency, administered under a more comprehensive knowledge of its subtle force than is generally or professionally understood." It would astonish those who are unaccustomed to the working of a hospital to see the number of applicants who appeal for aid to a new institution, who have already applied for relief to other older, larger, and richer hospitals in vain; and it is our pride and boast to assert, without fear of contradiction, that not one such case has been turned from our doors unrelieved; some, from the extreme severity of their symptoms, have attended during the whole time the hospital has been opened and are still uncured, but there has not been one who has not obtained relief.

The second object for which the Hospital was intended, was "to afford students and practitioners in medicine an opportunity of observing, studying, and testing the treatment of disease with the aid of galvanism;" and we have had much pleasure in observing the readiness with which the medical profession have responded to our invitation, many having availed themselves of the privilege, amongst whom, as is usual, some of the most eminent professors have been our visitors, and two even having availed themselves of the treatment.

The third object was, "to train and instruct nurses in the practical use of galvanic apparatus, so that they may be able, under medical supervision, to apply the current in certain cases of delicacy;" this also has been satisfactorily carried out, the lady superintendent having undertaken the application of the galvanic currents to the female patients, under the supervision of the surgeon.

Thus, then, we may consider that the first year of the London Galvanic Hospital has passed with success; the objects for which it was opened have been carried out to the letter, and no change has been required in its management; and we may now appeal to you for encouragement with every confidence and trust in your generous liberality; for when, indeed, has the British public been appealed to in vain to aid the wretched and succour the miserable?

In conclusion, and in resigning my post into the hands of your chaplain, who has most kindly consented to act for the future as your Honorary Secretary, I can only say that the prosperity of the Institution is my chief object, and that my best efforts will be expended to promote its welfare.

T. Brook,

Honorary Secretary.

The Surgeon's Report.

Twelve months' experience at a public institution of the value of galvanism in a certain class of cases, has only confirmed my previous knowledge of its great and wide-spread applicability to the alleviation and cure of many of the so called incurable diseases. The cases that have attended at the Hospital have been—as might have been expected—those that have met with no relief elsewhere; and in looking through the list, I cannot find one that would not have been considered one of great difficulty to ordinary treatment. But as these are the class for which we have laid ourselves out, it may not be considered strange that we have none of a less severe and painful character.

Ninety per cent. of the cases applying to the Hospital have been for some form of paralysis. There appears to be an innate instinct in the public mind that galvanism is the only agency from which a cure may be anticipated in this disease; in every instance—with no single exception—the patients have attended at some other Hospital previously; and the moment they became aware of the London Galvanic Hospital have applied to it for relief.

Rheumatic paralysis has most readily yielded to galvanism; of these I shall select two cases—the one taking the least time for a cure, the other the longest. "George Jones, 14, Polygon Street, St. Pancras, aged 63, applied on the 12th of February, suffering from contraction of the muscles of the left lower arm, so that the fingers resembled claws, and were fixed in one position, the skin was dry and scaly; this had been of ten days' duration, and had been induced by cold and wet. Galvanism was applied, and in ten minutes he could use the hand perfectly well; on his next visit he had retained all his power and was quite cured."

"William Pratt, 5, Buckingham Street, Pimlico, aged 54, applied on the 1st of January, complaining of paralysis of the right leg of twenty months' standing, induced by cold, the leg was very cold and the muscles were hard and stiff; there had been great numbness, but this had been removed by his medical attendant, but the paralysis remained unrelieved. The galvanism was applied for half an hour, with immediate benefit, as the foot felt warm and natural, and he walked home, three miles, very comfortably. The galvanism was repeated three times a week, and on January the 17th the leg was quite well."

All the cases of rheumatic paralysis have been cured with equal facility.

The next class of paralytic cases, arising from no actual central disease, but the result of some reflected injury or malady, may be looked upon as those next most readily yielding to galvanism; of these I shall select one case.

"Margaret Scott, 29, Oxford Street, aged 45, applied on the 11th of March, suffering from paraplegia or paralysis of both legs of seven years' duration, following upon flooding after childbirth. She could just shuffle along, complaining of great pain in her loins, hips, thighs, and knees, and great tenderness to the touch; she was also in a low state as to her general health: in this case the galvanism was applied so as to stimulate the general tone, as well as being used locally. Mrs. Scott immediately found relief, and very shortly was enabled to walk from the Hospital to her own house. She can now walk very well, and has quite regained the tone of her nervous system."

These cases of reflex paralysis yield very readily to galvanism, although they take more time than rheumatic paralysis.

The next class—paralysis from central disease, either of the brain or spinal cord—requires a more prolonged treatment, and although few are actually cured, all are relieved, and the great majority derive benefit enough to be able to carry on the ordinary occupations of life; of these cases I shall select two.

"John Stock, George Street, Langham Street, aged 45, applied October 2nd, 1861, complaining of paralysis of the right side, followed by shaking palsy of the same side; this man had been to many hospitals without relief; he had been paralysed eighteen years ago, but had recovered the use of his side to a great extent; for the last eighteen months he had lost the use of the arm and hand; could hold nothing, and was constantly shaking; the leg was very painful, and he was in a very weak and emaciated condition. Stock had been a bricklayer, and had been completely unable to work for a considerable period. He was brought to the Hospital by the Rev. Mr. Godson, of All Souls' Church, who took much

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interest in his case. Galvanism was applied with marked benefit, and in the course of a very few applications the agitation of the muscles was arrested; attention was then turned to the paralysis, and he regained steadily the use of his hand and leg, and in three months he was happily enabled to return to his work. This was a most satisfactory case, as the treatment enabled a man who had been out of work for a considerable period, to return to his employment, and this he has done regularly since."

The following case more resembles the paralysis resulting from shock, where there is great loss of nervous tone, and which would probably, if not arrested, terminate in softening the brain; of this form we have had several cases at the Hospital, all having done well, and one of great severity is now progressing with remarkable rapidity.

"J. Price, 120, Waterloo Road, aged 49, applied 20th of August, complaining of great loss of power in the left arm and fingers, accompanied with painful neuralgic attacks, great general weakness, with flying neuralgic pains all over the body, supposed to originate from excess of mental toil, he being a reporter for the press. He has attended at many hospitals without benefit. The galvanism was applied to the system generally, with rapid improvement, and then the arm was treated locally; he was discharged cured on October the 5th, having called several times since: he has had no relapse."

These instances show the wonderful power galvanism has over paralysis even in old-standing and long-neglected cases. I hardly need enter upon the subject of neuralgia, as it is now almost universally acknowledged that galvanism is a specific for that disease. There is, however, one more class I should like to call your attention to, as, although uncommon, still many instances have occurred in my practice, and two have applied for relief at the Hospital.

During the time of teething, infants are sometimes suddenly struck with paralysis, and as the growth of the limb is consequently arrested, very disagreeable results follow, lameness and distortion being amongst the number; the same accident not unfrequently happens after some of the fevers of youth, as after scarlet and typhoid fever, hooping-cough, &c.

"Catherine Lee, 6, Great Crown Street, St. James's, aged two years, applied October 2nd, 1861, with wasting paralysis of the deltoid, triceps, and biceps of the right arm, the lower arm was not the least affected, but there was not the slightest power in the upper arm; between the head of the bone and the cavity to receive it, there was a space left, within which the finger might be laid. The paralysis had occurred suddenly about four months previously, during teething, and the wasting had come on by degrees; if this state could not be removed, the poor little thing would lose the use of the arm for life. Upon stimulating the arm with the galvanic current, not the faintest trace of muscular contraction could be discovered in one of the paralysed muscles; this, however, did not dishearten us, but the treatment was steadily persevered in, and we were rewarded after six weeks' labour by discovering slight action in the triceps; this gradually improved, until in three months, voluntary contraction supervened; the deltoid was also increasing in size, but the biceps had neither gained in size nor contractile power. It was on the 5th of May the first voluntary contraction in the biceps was perceived, from this time the improvement was more rapid, and she has now voluntary use of the biceps and triceps."

This case has been, perhaps, the most satisfactory that we have had at the Hospital; for, looking at the tender age of the child and the great deprivation the loss of the right arm would have been to her, we cannot look upon her recovery as anything less than most encouraging; for had she not attended at the Hospital she never would have had the slightest use in the arm. I will not trespass further upon your time, although there are many cases I should wish to bring to your notice, especially some of neuralgia which have yielded to the treatment; but, in conclusion, I may be allowed to observe that the number of cures, considering the severity of the diseases, has been very large; and although much time has been required to effect the desired objects, still the result has been most satisfactory.

Harry Lobb,
Surgeon to the Hospital.

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	1s. 11d. to 2s.	per lb.
Second „	1s 6d. to 1s. 10d.	„
Third Negro	1s. 1d. to 1s. 2d.	„
Java	1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine none worth	2s. 8d. and above.	
Genuine mixed	1s. 9d. to 2s.	per lb.
Reboiled good	1s. 5d. to 1s. 8d.	„
Ordinary ditto	1s. 0d.	„

April 8, 1863. Wm. Kirkmann,
4, Howford Buildings, Fenchurch Street, E.C.

TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	65 to 69	———
Stock	Electric Telegraph . .	100	100 to 102	———
5	London District Telegraph .	all	2 to 2½	———
10	Mediterranean Extension Tel.	all	3 to 4	———
1	Submarine Telegraph, scrip. .	all	⅛ to ¼	———
2	Telegraph to India (limited) .	1	¾ to ⅞ dis.	———
5	United Kingdom Telegraph .	8	par to ⅛ pm.	———

PROTECTION OF SUBMARINE CABLES.

Although Submarine Telegraphy has received such vast extension during the past twelve years, it is curious no steps whatever have been taken in a legal point of view for the protection of cables when laid.

It is well known to those who have to repair the damage done in telegraph cables, either wilfully or otherwise, that one-half of the breakages could easily be avoided with only ordinary precautions on the part of mariners.

Not long since a Swedish vessel hove up a telegraph cable about six miles from the English coast, and was actually told how to free it by some Deal boatmen; by the advice of the mate the captain obstinately refused to comply, consequently when the tide began to make, the strain of a heavy barque was too much, and the cable was broken. What remedy has the Company in such a case? Can they proceed criminally against the captain, or civilly against the owners for compensation for the wilful act of their servant?

To quote a more recent case: we notice an advertisement in the *Shipping Gazette* offering a reward of £50 for the conviction of some party who had moored his vessel to one of the green nun buoys attached to a cable under repair and breaking it away, thus necessitating the work to be done over again. We feel anxious to know under what Act of Parliament the offender could be punished.

What is really requisite is an international law on the subject. Every country with any seaboard has now its submarine telegraph cable, and is equally interested with ourselves in its preservation. The co-operation of foreign governments is almost certain, and it is only necessary to draw up a treaty on a proper footing for it to immediately meet with their serious attention.

Every year there is a conference held at alternate centres of the continental telegraph administrations. To these conferences is delegated a chief officer from each government, and an international treaty is concluded which becomes law in all countries there represented.

Might not the English Government nominate some one conversant with the matter at the forthcoming conferences to represent English interests. Let this gentleman meet the engineers of the different companies possessing submarine telegraph cables, and draw up a code which may afterwards be so altered and ratified as to meet the requirements of all interested.

With power to punish those who maliciously or carelessly damage telegraph cables, a great portion of the failures we are obliged to announce from time to time would probably cease.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of the Electrician.

Sir,—A few words in notice of Mr. Latimer Clark's letter in your impression of March 27, are perhaps due from us. It was through our not being aware of your day of publication that they were not sent to you last week.

It was well known from the outset that the length of india-rubber insu-

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lated cable submerged at Kurrachee was of very defective manufacture. A reference to Mr. Fleeming Jenkin's tests, which Mr. Clark has invited, will prove this. Those tests are in juxtaposition with tests of the gutta percha core used for the Red Sea cable, and show that, notwithstanding the now uncontroverted superiority of india rubber, in the quality of insulation, over gutta percha, that particular piece of cable tested worse than the gutta percha one. The explanation of the inferiority is in the system of the manufacture, which we found to be so bad that we abandoned it immediately after our experience with that core. The cable, therefore, was sent out to be a test, not of the manufacture, but of the material.

The defects now observable in it are quite in accordance with its original condition, and have doubtless been exaggerated by the treatment it must necessarily have been subjected to as a light shore end entrenched in a heavy beach. They were proved upon Messrs. Bright and Clark's own premises (and admitted by Sir Charles Bright) to be, not "*general*," as Mr. Clark states, but *local*, or, in other words, to be *distinct* "*faults*," and their exact positions have been demonstrated, establishing conclusively that they were solely the result of the method of manufacture.*

On the other hand, the test as to the effect of tropical submersion upon the material, is perfectly satisfactory: though, in fact, only what everyone who has had lengthened experience in the many applications of india rubber, would have had no hesitation in foretelling. It is in no way impaired. Mr. Clark is therefore mistaken in affirming that it "had lost its insulating properties." The peculiar change or hydration does not in the least affect insulation. Dr. Miller has sufficiently established this, as any one may see who consults the Government Report. "The loss of colour" is simply the return of the gum to something like its original hue, on its being deprived for a sufficient time of the action of the air, and we beg to refer Mr. Clark to this very cable for proof, that, on being re-exposed to the air, the rubber re-assumes its darker colour.

The facts about this cable, then, are simply these; that it was very faulty to begin with, and that the faults have been confirmed, and that rubber is unimpaired after two years' submersion in the tropics.

In conclusion, Mr. Clark thinks it almost certain, "that before long we shall see it (india rubber in some of its forms) in extensive and successful use;" but he holds that "two things are requisite for this end—one is, the experience of a practical test of its efficiency, such as that obtained at Kurrachee." We are happy to be able to offer him that. A length of about three miles of cable, manufactured by us for the Mersey Docks and Harbour Board, has been laid across the Mersey for about a year. Mr. J. S. Gisborne, the engineer to the board, has testified, that the insulation has not in that time been in any way impaired; and we have the authority of Mr. Gisborne to offer to Mr. Clark, or to any other electrician, full scope to examine that cable in its entire length,—now, that it has been taken up owing to the continual dangers from anchorage. Mr. Clark may thus amply test the effects of "hydration" upon the insulation. We can refer to still better tests, if this should not suffice.

The other requisite is, "an assurance that the manufacturers have had sufficient experience in its manipulation to give it *all the perfection of which the material is capable.*" This is surely a little hard, or would be if Mr. Clark had not previously expressed his conviction that "before long" the result of this perfection would be seen in "extensive and successful use," and thus turned the condition into a high compliment. Anyhow, if Mr. Clark will kindly tell us how much "perfection" (to use an Irishism !) he must exact as the second condition of this success, we will endeavour to satisfy him without loss of time.

The Manufacturers.

To the Editor of The Electrician.

Sir,—I am sorry that M. Blerzy should do me the injustice to suppose that I did not read and re-read the whole of his paper.

I attacked his argument, he has attacked my powers of translation; therefore there is scarce any answer possible to me other than sending him, as I propose to do, works from authority which will show where is the error, and which of us is the "heretic" as to the theory of cable laying.

But as practice can have comparatively little to do with describing the curves of cables which no one ever saw or will see in course of deposition; I do not understand the force of the accusation "that I take a purely practical view of the question." Even if it were so, I would beg M. Blerzy to believe, as I think scarce any one will deny, that an ounce of practice is worth a pound of theory, though I am quite ready to confess that neither is worth much when they are disassociated.

M. Blerzy will shortly receive from me all that I can contribute to his advancement in knowledge of the subject. In sending him Mr. Gravatt's able mathematical exposition, which he cannot easily otherwise obtain, except in the proceedings of the Royal Society, I shall so contribute to a very considerable extent. The Astronomer Royal entirely mistook the whole question, something as M. Blerzy has done, and Mr. Gravatt completely and clearly demonstrated before the Royal Society how he had fallen into error.

It is a curious way of "defining" and "simplifying" a question to assume the existence of a state of things (such as the catenary curve) which never can in ordinary practice take place with deep-sea cables, and then only to glance at the real state (the upward curve) which generally, if not always, must exist.

M. Blerzy says, "Au reste, peu importe la forme de cette courbe, car nos raisonnements restent applicables à une courbe quelconque, *sauf*, &c." I am sorry I cannot agree with him; nor would the surface currents.

J. H. Selwyn.

To the Editor of The Electrician.

Sir,—I beg to thank you for your information on the subject of Secondary Batteries, and think others, like myself, will be much gratified with the powerful results obtained by so small a consumption of material. Acting upon the several instructions given in your articles, I obtained a piece of thin sheet lead, seven feet by six inches wide (cost ten pence), and a similar piece of thin sheet zinc (cost one shilling). I made a separate roll of each and immersed them in *very* diluted sulphuric acid, and connected the lead with the copper pole, and the zinc with zinc pole of four small Daniell's. In about half an hour a dark brown substance (peroxide of lead) formed on the lead, *but only on the outside* portion of the roll of lead, the peroxide being thicker on that portion of lead nearest the zinc of the secondary battery. Without disconnecting the primary (which is not necessary with this secondary battery), I brought a wire from the zinc, and also one from the lead, and attaching a piece of thin iron wire to the two ends, I was much delighted to find that the wire came to a bright red heat for about *one inch* and continued so for some time, *whereas the primary battery would not have produced this effect alone.* Thinking that the power of the secondary battery might be further increased, I kept the four Daniell's charging the secondary for *six hours*, but no further power could be obtained, although the peroxide of lead became more dense on the lead, *and still only covering about a foot of the lead.* Thinking that the remaining six feet of lead was but superfluous, I detached the portion covered with the peroxide, and a similar sized piece of zinc, and rolled them upon each other, separated by stout brown paper, and immersed them in the acid solution. Judge of my surprise to find that this arrangement was capable of heating a piece of iron wire *nearly two inches* long to nearly a white heat. Now here was a piece of zinc and lead exposing about *a foot of surface only*, giving greater results than two pieces exposing nearly *four feet* square surface. I attributed the increase of power to the metals being brought closer together by being rolled on each other, separated by the brown paper; this arrangement could be charged in about thirty minutes; any greater increase of time in charging did not give any better results. As an increase of power seems to be gained by bringing the metals (lead and zinc) in close proximity, I intend forming one by rolling the remaining six feet of lead and zinc on each other, separated by canvas, and shall be happy to let you know the results. You mention that the zinc in the secondary battery will not be acted upon while it is in connection with the primary battery. I find that this is not the case in the one I have constructed; the zinc (not amalgamated) is violently acted upon even when in connection with the primary battery, and until this action ceases, the power of the secondary battery does not seem to commence, and even when the secondary battery is in action the addition of more acid to the solution does not increase the power. It would appear that better results are obtained when the solution is saturated with sulphate of zinc only. Apologizing for trespassing on your space so much, I remain, yours, &c.,

J. Cook.

To the Editor of The Electrician.

Sir,—One word respecting Mr. Laming, of whose later lucubrations I am most heartily tired. When will they end, or when shall we find something that we can either understand or appropriate? He professes to have weighed electricity (+ electricity) in a manner "pronounced faultless by the leading electricians of the Institut de France. It was proved to their satisfaction that a body falls more forcibly towards the earth when electrically plus than when minus, all interferences by what is known as electrical attraction being effectually guarded against." Would Mr. Webb be satisfied with the demonstration? or has Faraday or any English electrician endorsed the statement?

Believing in the materiality of electricity, I would most gladly entertain the idea, but it occurs to me to ask a very curious question connected herewith—one of general interest—and which might well be recommended to the consideration of Mr. L. Clark, whose genius is fertile in this connection.

Assuming the correctness, or superior probability of the modern notions of one electricity, as compared with the older view of two fluids; may we regard with complacency the manner in which the terms *vitreous-resinous*, or *positive-negative*, or *plus-minus*, *originated under the old regime?*

Positive-negative, are terms which simply express the idea of polarity, of antithesis, of opposite properties on opposite sides, and might just as well be reversed, with no violence to language, or incompatibility of idea; not so, however, with the terms *plus*, *minus*; these express antithesis, and *something more*—the idea of fullness and emptiness.

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* We submit for your inspection the piece of the core politely handed to us by Sir Charles Bright. The method of manufacture was, first a strip of rubber laid on *longitudinally*, and then one laid on *spirally*. It is plain that the junctions were imperfect, and the faults lie accordingly. It is the longitudinal part of the method that we have abandoned, and with the best results.

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Now, suppose it were to have so happened that these terms had, by a perverse inadvertency, been started in the wrong direction, then the academicians would very quixotically have weighed an empty vessel, and proved to their "entire satisfaction" that, in a manner "pronounced faultless," it weighs more than a full vessel!

Beyond all this, I venture to predict that this has been the case, but who shall decide?—Yours, &c. S. E. Phillips.

P.S.—Whatever interest may attach to this prediction, I wish it to be understood that the whole stress of this inquiry is rather as to the origin of the terms, whether they were haphazard and entirely empirical, and, for aught that is known to the contrary, in the way I have indicated.

March 30, 1863.

To the Editor of The Electrician.

Sir,—Having accidentally met with your impression of February 27th, I read your notice of Messrs. Gilmore and Preece's invention for steering ships, I write to inform you that the idea is much older than the patentees claim, as I had a similar instrument on board the Cork Steamship Company's ship *Ajax;* this vessel was lost on the Mewe Stone, off Plymouth. Eight years ago it was sent in her to test the verticity of the needle during the change of position and oscillations of the ship, in charge of my friend, Richard Sunners, Engineer, and was eminently successful, not requiring to be hung on gimbals as in Messrs. Gilmore and Preece's; was a very inexpensive affair. There was also a similar instrument for the engine room, which opened the valve of the steam whistle for an alarm. The above instruments were designed for the *Great Eastern*, but never presented to the notice of the directors. If this should meet the eye of any one desirous of manufacturing, I shall be happy to give any information gratuitously, of course not subjecting myself to any expense. —I remain, &c., H. Farrington.

Barton Hill, Bristol, April 2, 1863.

To the Editor of The Electrician.

[A New Pile—the *pile Vérité*—is described in the last number of *Les Mondes* (the new French scientific periodical, so ably conducted by the Abbé Moigno); and it would appear to rival, in the combinations of simplicity and power, the best that we at present possess. In a cylindrical glass or porcelain vessel, is placed concentrically a similar one made of thin copper, of half the height and diameter of the outer one, and to this copper vessel is soldered a wire to act as the positive pole, or to form a connection with another element. Between the inner and outer vessels is placed a plate of zinc, suspended from the edge of the outer one so as not to touch the bottom of it, and to this plate is affixed the wire to serve as the negative pole. The copper vessel is charged with the sulphate of the same metal, and round it is placed a little salts of zinc, in order to render the water with which the larger vessel is filled a better conductor. The pile being thus charged operates immediately, the consumption of copper being almost *nil;* to prevent evaporation, an inverted Florence flask filled with sulphate of copper and water may be superposed, the neck being introduced into the copper vessel. The advantages of this very simple arrangement are, that the current is constant in intensity, the tension is greater than in any other sulphate of copper battery, and that it is almost impossible to mix the two liquids. J.N.L.]

Sir,—What do you think of the above description of battery? It appears to me to be a great improvement on the "Callaud" and "Minotti" form of sulphate of copper batteries. I altered the arrangement by substituting in the place of the copper cell a small glass jar filled with sulphate of copper solution, and placed in the glass jar a piece of thin copper exposing about the same surface as the zinc, and charged the zinc with sulphate of zinc solution—the copper solution remains entirely in the glass jar, without mixing in the slightest degree with the zinc solution, and I think you will find that both the tension and quantity are equal to any Daniell's form, and this arrangement has the advantage that the fluids do not mix, though in perfect contact; nor has it the resistance of the porous cell to overcome. The remark as to consumption of the sulphate of copper I think is nearly correct. I intend trying the cells of copper, and will let you know the results. The simplicity of the construction and great constancy of action, coupled with the less expenditure of sulphate of copper, is a great recommendation for its merits to be made known, and will be found very convenient for experimental purposes, as a number of them can be very soon constructed.

I shall deem it a favour if you will inform how sulphate of copper can be made, as I have a lot of old bits of copper that are useless but for this purpose.—Yours, &c., J. Cook.

To the Editor of the Electrician.

Sir,—I derived much satisfaction in reading your leading article in the impression for March 27th, of the Electrician on "Medical Electricity" as it is by far the most efficiently written one that I have met with, it embraces the real fundamental principles upon which a rational method of electrical treatment is to be based, and without entering into any medical particulars, is a comprehensive article, for if the effect upon the nervous and circulatory systems be understood by an efficient physiologist, the application of electricity to the treatment of disease is merely the result of practice. To quote your words, "we find that in electricity we possess a duplex power of influencing physiological action," the continuous persistent galvanic current has the property at the *negative* pole of increasing capillary circulation, of loosening tissue, of softening it, of augmenting the temperature, and of increasing secretion and excretion, this is the hydrogen pole of the battery; at the positive or oxygen pole the effect is different, it is not so marked, circulation is not so much increased, or is secretion stimulated.

The interrupted galvanic current, or the broken electro-magnetic, or magneto-electric currents, arrest circulation, and cause muscular contraction. There can be no doubt that these have their own special spheres of usefulness, that each is valuable in its way, but that the continuous current has the much wider field, is quite clear to my mind. I have now been occupied in the study of medical electricity for six years, both in private practice and at the London Galvanic Hospital, so that I have had an extensive experience in the application all of forms of electricity, and I am satisfied that for the majority of the cases coming before the medical practitioner, the voltaic current is by far the more generally useful.

I beg to enclose some of my writings on the subject, and shall be happy to contribute to your paper, should your readers take any interest in medical electricity.—Yours, &c.,

Harry Lobb.

70, *Brook Street, Hanover Square,*
April 4th, 1863.

To the Editor of The Electrician.

Sir,—As I am constructing a large induction coil machine I find I need a little advice thereon. The secondary wire consists of about 24,000 yards of silk-covered copper wire, diameter ·0066 of an inch, which I intend to wind upon an ebonite cylinder 30 inches long, divided into 200 compartments by their annular discs of the same material.

The primary wire consists of about 250 yards of cotton-covered copper wire, diameter ·1 of an inch, divided into four lengths, and wound upon a hollow cylinder of wood, internal diameter 2½ inches. This I shall fill with a bundle of iron wire, diameter ·03 of an inch.

Now, would you advise me to saturate the secondary wire (or rather its covering) with spermaceti, as recommended by Poggendorff?

According to Mr. Owen Rowland's letter on "Insulating Compounds" in the Electrician for March 13, 1863, the spermaceti would be of no advantage, but even the contrary. If you would be kind enough to give me your opinion thereon in your next publication I should feel greatly obliged.

When I have completed this machine I will furnish you with all the particulars of its construction, and likewise its power and cost, if you like. —Yours very respectfully, J. C. Frank.

Rhydairy, Oswestry, March 26th, 1863.

P.S.—Any suggestions of yours would be very acceptable.

SUBMARINE TELEGRAPH CABLES UNDER HIGH PRESSURE.

To the Editor of The Electrician.

Sir,—Will any of your readers, or more especially any member of the Institution in Great George Street, the President of which lately claimed telegraphy as an *additional branch to the profession of civil engineering*, enlighten me upon the following point? It appears from experiments made, that the following materials are crushed by being subjected to the amount of pressure placed against each:—

Cast iron	10,000 lbs.
Cast copper	7,318 „
Wrought copper	6,440 „
Brass	10,304 „
Tin	966 „
Lead	483 „
Elm...	1,284 „
Pine	1,606 „
Oak...	3,860 „

Therefore, what has been the effect of the pressure of 1,500 fathoms of water upon any of our submarine cables?

I should observe that the metals above enumerated in the list consisted of ½-inch cubes, and the wood of 1-inch cubes.

Mr. Gisborne is not, evidently, aware that gutta percha is a non-alimentary substance, and that no living being, either on sea or land, can long thrive thereon.—Yours, &c. Omicron.

Telegraphic News.

ATLANTIC TELEGRAPH.

Mr. Cyrus Field has addressed a large meeting at the New York Produce and Stock Exchange, upon the subject of the Atlantic Cable.

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Resolutions declaring confidence in the success of the undertaking, and appointing committees to raise the remaining capital necessary, were unanimously passed. Upwards of £18,000 are already subscribed, and the subscriptions were progressing favourably. We also understand that meetings have been held in Philadelphia, Boston, Baltimore, &c. It is fully expected that the contributions will considerably exceed £50,000 within the current month. We have been informed on good authority that some of the original shares of £1,000 each have been sold for from £400 to £500 sterling.

Greencastle—Important Telegraphic Extension.—The submarine cable connecting this station with the whole European telegraphic system, was, on Thursday the 2nd inst., successfully submerged by B. D. Watlock, Esq., Chief, and Messrs. M. C. Greenhill and H. Black, Assistant Engineers to the Magnetic Telegraph Company. The weather was rather unfavourable for the work, but all arrangements having been made, and as the steam vessels with the cable on board, under the excellent arrangements of Captain Coppin, had arrived the evening before, the engineer determined on laying the cable without delay. The cable was laid most satisfactorily, and the landing on the Derry and Donegal shores was a source of great excitement to the large concourse of people assembled, and elicited enthusiastic cheering. Messages were sent direct to London, Liverpool, Dublin, Belfast and Derry, and replies received instanter. We believe this extension will be of the greatest importance to the whole of the United Kingdom, as the American steamers can be signalled immediately they enter Lough Foyle, thus securing a saving of from two to three hours in transmission of despatches and news.

The following is taken from the *Londonderry Sentinel*:—"A communication by telegraph, from Greencastle itself, announces both practically and in words that the submarine cable connecting that station, near the mouth of Lough Foyle, with the whole telegraphic system of the United Kingdom, has been successfully submerged. The work was tested by sending messages to various places and receiving replies. It is unnecessary to dwell on the importance of this extension, not to Derry alone, but to the whole empire, as we have previously pointed out in detail the advantages connected with it. Foremost, however, is the fact that the Canadian steamers can be signalled at once on their arrival, and that two or three hours will be gained in the transmission of news and despatches. The shipping, commercial, and general interests will derive corresponding benefits.

Miscellanea.

THE LATE DR. HAMEL

Dr. Joseph Hamel, who, it will be remembered, was a frequent contributor to our columns, was distinguished by the invention of an electrical machine. In 1820 Dr. Hamel made a well-known ascent to Mont Blanc, when he lost several of his guides. He was elected, in 1828, "Membre de l'Académie Impériale des Sciences de St. Petersbourg." It was through his exertions that the first exhibition of industry took place at Moscow. He was afterwards employed in several other exhibitions in Russia, and, taking the liveliest interest in the progress of industry, he visited all the great exhibitions which have since taken place in France, England, and even the one at New York in 1854. Dr. Hamel published a history of the steam engine, a work written with the precision and care distinguishing all his scientific researches. He also published a history of the electric telegraph, which is very complete in a scientific point of view.

Deaths from Nitric Acid.—A very painful sensation has been caused in Edinburgh by the death of Mr. Stewart, one of the masters, and also of the janitor of the Edinburgh Institution, a large educational establishment in Queen Street. Mr. Stuart was in the laboratory of the school preparing for some chemical experiments, and while carrying a jar of nitric acid across the room, it fell on the floor and was broken. He called the janitor to his assistance to wipe the floor and to endeavour to save a portion of the fluid. In this effort both unwittingly inhaled its deadly fumes. Mr. Stewart went home to dinner, unconcious of the injury he had received. After an hour or two he began to experience difficulty of breathing, and sent for medical advice, but he very rapidly became worse, and expired at two o'clock on Wednesday morning, about ten hours after the accident. The janitor was also taken ill, and, though he rallied for a time on Wednesday, he afterwards sank, and expired at five o'clock on Thursday morning. Several of the most eminent medical men in the city were called to the unfortunate patients, but their skill proved unavailing. The case, it appears, is almost without a parallel in medical experience.—*Chemical News.*

The following communication, relating to the effects of the vapours of nitrous acid, has been addressed to the Editor of the *Chemical News*:—"Sir,—Some years ago, after experimenting for some time with Callan's battery, I was attacked with a sort of pleurisy, which the doctor (Mr. Nicholls, of Saville Row) attributed to the fumes from the battery."—I am, &c., John S. Blockey.

Electro Deposition of Aluminium.—In a patent taken out by F. S. Thomas and W. E. Tilley (1855), the following solutions are described as adapted "for plating or coating metals with aluminium and alloys composed of aluminium and other metals. No. 1. Solution of alumina.—Calcined alum and cyanide of potassium, in certain proportions, are dissolved in water by boiling. No. 2. Solution of alumina.—The precipitate resulting from mixing solutions of alum and salts of tartar is boiled in an iron vessel, with a solution of cyanide of potassium. No. 3. Solution of alumina.—The precipitate resulting from the addition of ammonia to a solution of alum is treated in the same manner as stated in No. 2. No. 4. Solution of alumina.—The precipitate obtained by adding carbonate of potash to alum (both being in solution) is wasted and melted with cyanide of potassium; a certain amount of carbonate of soda is then added and fused; the solution of the mixed ingredients in water affords the electro-depositing solution. Aluminium is electro-deposited either by an anode of aluminium, or by an anode of platinum and a bag of *alumina* to replenish the solution. An electric current of considerable intensity is used in connection with the above-described solutions.

The application, for the purpose of electro-plating, of a thermo-electric battery, consisting of alternations of German silver and iron rods, was patented in 1843 by Moses Poole. The silver solution employed was made by adding carbonate of soda and carbonate of silver to a dilute solution of hyposulphite of soda or potash. In working this solution, free hyposulphite and carbonate of soda were added from time to time.

The alloy of copper with aluminium, which seems likely to introduce new dangers into our gold currency, is stated to be the invention of the ingenious author of "Dual Arithmetic," Mr. Oliver Byrne, who has paid particular attention to metallic alloys. The inventor has, it seems, the means of modifying the appearance of his alloy so as to imitate any description of the precious metal to which it assimilates, from jewellers' gold to gold coin; and it is related, that, having been requested to show some specimens of it to a banking firm, he threw four or five sovereigns upon the counter, and successfully defied the high priests of Plutus, then and there present, to detect the one among them which was counterfeit. As this metal can be compounded for ordinary purposes at a few shillings per ounce, it will be seen that the invention is one of grave practical importance.—*The Reader.*

The Preservation of Timber.—M. Crepin, a Belgian Government engineer, who has tried experiments upon the relative advantages of creosote and sulphate of copper for the preservation of timber in marine constructions from the attacks of worms, &c., says, that creosoting is the only process he has found to succeed for this purpose. He states that sulphate of copper affords no protection whatever against the action of salt water and marine insects. The Belgian Government now require that all the wood sleepers used in the State railways should be creosoted; and the Government of Holland have also made the same resolution, and upwards of 300,000 sleepers per annum are now being creosoted by the Dutch Government, and more by the Belgian Government.

Paris Academy of Science.—A paper was read at the last sitting by M. Lucian de la Rive, on the "Conducting Power of Thallium for Electricity." As this new metal is slightly soluble in water, viz., in the ratio of 1 to 500, its density had to be determined in naphtha, and turns out to be 11·853; whence its conductibility for electricity varies between 5·21 and 5·28, at a temp. of 12° C, or 53·6 Fah.

To Correspondents.

Benjamin R. Mills.—The instrument you describe might answer very well as a contact breaker and "reverser," but is evidently not adapted for the purpose we had in view in last week's "Student," viz.:—the connection of the cells of a battery either for "quantity" (by their similar poles), or for tension (by their opposite poles). What is most wanted is an apparatus by which this may be instantaneously effected; but the contacts must not be liable to fail, and the instrument should neither be cumbrous nor very expensive to make.

E. F., Exeter.—We shall have much pleasure in inserting your communication, with sketch, in our next. For a battery of few elements the contrivance will be found very useful; but for use with secondary batteries, or for battery of 60 or more cells, a "single motion" commutator is needed. Perhaps you may be able to furnish this desideratum. That which we have constructed is in the form of a wheel with many spokes, each of which makes a spring contact: it is somewhat complicated, and would, we fear, be expensive to make.

J. Cook.—In the method you first adopted in arranging the elements of your secondary battery the advantage of extended surface was altogether lost. What is commonly termed a "quantity" cell or battery, is, more correctly speaking, one of small "resistance" The resistance to the passage of electricity in the battery itself (with a given "exciting fluid" or electrolytic conductor) is directly as the distance between the plates and inversely as the extent of their surfaces. So that, in a quantity battery, not only should the surfaces be large, but in close juxtaposition throughout. You will find this well verified fact a safe guide in future. You might with advantage employ six Daniell's cells (of course arranged for tension) instead of four, as the primary battery. We will try the *pile Vérité*. You might boil your old copper with sulphuric acid in a Florence flask, to form the sulphate; but it would, we think, be much cheaper to buy the salt. This is made by oxidizing the sulphide of copper—an ore of the metal.

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The Electrician.

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M. DU MONCEL ON THE POLARISATION OF EARTH PLATES.

A paper of M. Du Moncel, entitled "Researches on Electrical Transmissions through the Earth in Telegraphic Circuits,"* contains matter of some interest, if not of some importance, to the scientific telegraphist. The author, a high authority on telegraphic matters in France, observed that when a positive electrode of large surface is opposed to a negative electrode of smaller surface, the current is of less intensity than when, *ceteris paribus*, the anode is of smaller dimensions than the cathode. It should be stated that the electrodes were of iron, and under such conditions as readily to become polarised. The observation is not new, though hitherto it has received but little attention and no extended confirmation. In a series of papers by Mr. Christopher Binks, published in the *Philosophical Magazine*, in 1837-39, it is asserted, on the strength of very many carefully conducted experiments, that to obtain the maximum effect from a zinc-copper couple, excited with dilute sulphuric acid, the surface of the negative element should be sixteen times greater than that of the positive element. Of course, in the voltaic couple the positive element constitutes the anode, or positive electrode,—the negative element being the cathode, or negative electrode,—in relation to the fluid of the cell. In the couple in question, moreover, the polarisation of the elements is not prevented by the action of an oxidizing agent upon the negative plate. The conclusion arrived at by Mr. Binks, which, from its definite character, certainly merits attention in connection with the present subject matter, is therefore not necessarily at variance with the laws of the circuit as established by Ohm, and may probably be found to be in complete accordance with them. At the same time it tends to confirm the less comprehensive observation resulting from the experiments of M. Du Moncel.

Were it not for the carefully given details of these experiments, the perusal of the thirty pages over which the article by the last mentioned electrician extends would sorely try the patience of any reader to whom the phenomena of what has been termed the terra-voltaic couple, or those of the polarisation of electrodes, might be tolerably familiar. Without being guilty of any disrespect, to what we believe to be a well deserved reputation in electrical science, we may say that, wherever M. Du Moncel attempts to explain the effects observed, his statements and hypotheses are often difficult of comprehension from obscurity of diction, and, when understood, are found to involve glaring inaccuracies. But for this, we should have been inclined to translate the paper *in extenso* for the benefit of those of our readers who have lately studied, in the phenomena of secondary batteries, the polarising effect, which is due to electrolysis, and which Daniell and Grove so successfully removed from the voltaic combinations which bear their names.

The first portion of the paper in question is devoted to the "terra-voltaic" current, in France termed *courant tellurique*, or confounded with "earth currents" properly so called, and to the current which, when plates of the same nature are placed in the earth and connected by an insulated wire, result from the difference in the chemical nature of the portions of soil in which these plates respectively are buried. The "terra-voltaic" couple, as most telegraphists are aware, is simply a positive and a negative plate of metal placed in the earth, at any distance apart, and connected by a wire insulated from earth. The earth, in fact, is employed as a "cell," with the advantage that, under certain conditions, the internal resistance of the circuit so formed is wholly inappreciable, even with elements of small surface. This advantage, we must add, is counteracted by the far more serious objection that the working tension is limited to that of a single couple. In connection with this subject, M. Du Moncel mentions the names of professor Kemp, of Edinburgh; Mr. Fox, of Plymouth; M. Reich, Mr. Bain, M. Palagi,—who, by means of chains of carbon and of zinc placed in the river Seine, marked a needle telegraph of Wheatstone between Paris and Rouen,—and Messrs. Hoge and Piggott. The results obtained in this country by Mr. Septimus Beardmore, who, by means of an element of zinc-sodium at Islington, and a plate of graphite in nitric acid at Heligoland, transmitted distinct signals through the Cromer-Heligoland cable, are not referred to. These certainly form the culminating point of an investigation which, however barren it may have been of practical applications, is of no small interest in a scientific sense.

Thus, says M. Du Moncel, "by connecting two conducting plates which are not oxydisable in the same degree, and which are buried in the earth at a given distance from each other, there should be produced either a telluric current due to a different electrical condition in various portions of the soil, or a current due to the oxydation of one of the plates."

The above appears to signify that one of the two currents must become manifested to the exclusion of the other. This, however, is not the author's meaning. He says:—

"It remained to be found whether, in a telegraphic circuit, where the earth-plates are constituted of the same metal, generally malleable or cast iron, the two telluric currents exist simultaneously, or whether there would be but one. The following are the experiments I have undertaken in this direction."

We cannot perceive that the experiments in question determine or even refer to this point; and the very small degree of importance which can be attached to the latter is, perhaps, the reason of its having been thus overlooked. Doubtless the two currents may occasionally co-exist; for the two plates of iron may not be oxydisable in the same degree, or one, by reason of the oxyde upon its surface, may be negative in relation to a cleaner plate, while on the other hand this current may be neutralized, diminished, or increased, by the earth current previously referred to. M. Du Moncel employed, as one of the elements of a terra-voltaic couple, the iron water conducts at Grenelle, near Paris; the other element being a plate of sheet iron, placed about one yard below the surface of the ground, and thoroughly moistened. The length of wire uniting the two elements was 1,735 *metres*. A delicate galvanometer placed in circuit gave a deflection of 9° 17′, indicating a current (*through the wire*, we imagine,—for the author does not inform us whether this applies to the fluid or to the metallic portion of the circuit) from the water conduct to the small plate. In twelve days the galvanometer had gradually fallen to 3° 33′. The plate was then again moistened with water, when the indication rose to 4° 51′, falling in twenty days to 1·41′. A second series of experiments was made under conditions similar to the above, with the exception that the plate of iron was buried in very dry earth. Here the first indication was only 3° 45′, falling in six days to 1° 47′. When the plate was now moistened, the deflection became 4° 53′, and in nine days was 3° 18′. In a third series of experiments two plates of iron were used as the elements of the couple, giving a slight indication of a current, the direction of which was reversed when the earth surrounding the plate acting as a negative was saturated with water. A fourth series of experiments was made by connecting the gas and water conducts, when a current, constantly varying in intensity, and ultimately in

* Annales Télégraphiques. Septembre-Octobre, 1861.

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its direction, was indicated by the galvanometer. The conclusions arrived at are that these currents are due to the oxidation of the buried plates (or rather, we should say, to the difference in the degree of oxidation which takes place upon them respectively); that they result from a difference of humidity in the soil surrounding these plates; and that their intensity increases as the earth surrounding one of the plates becomes more fully moistened, and as that in contact with the other plate becomes more dry. It is suggested that it might perhaps be of advantage so to connect the battery in a telegraphic circuit that the battery current and the "telluric" current may be in the same direction. When it is considered that the electro-motive force of the latter is less than one-fifth of that of one element of Daniell, this precaution appears somewhat unnecessary. It might be otherwise if the negative terminal were connected to a plate of copper, or better, of lead surrounded by the peroxide of the metal, and the positive terminal to a plate of zinc. Thus, polarisation of the earth plates would be prevented, and the battery power increased. This, however, would not answer for the system of working by reversals. In this case, the polarisation of the earth plates by the alternate currents—which takes place but to a very small extent—cannot be said to be detrimental; it may be shown to be of advantage rather than otherwise. But we are anticipating our subject-matter, and losing sight of the views of M. Du Moncel, which we must further enter upon in an early number.

(*To be continued.*)

SILVERING AND GILDING FABRICS AND OTHER ORGANIC SUBSTANCES.

Every thread in a fabric, composed of silk, linen, cotton, or other textile material, may be silvered or gilt by the following means:—The material, after being well washed, is immersed for a few minutes in a concentrated solution of gallic acid, and, when nearly dry, is transferred to a solution of 1 part of nitrate of silver to 50 of distilled water. By the reducing action of the gallic acid, a portion of the silver becomes precipitated upon the fabric, coating the threads with a delicate, but brilliant, film of the metal. The same action takes place when a solution of the chloride of gold is employed in lieu of the silver solution, the salts of gold being reduced with great facility by gallic acid.

The deposit of silver might, obviously, be increased, and rendered more durable by the action of the battery; but the same effect may be produced by another solution, similar to those recently described for silvering glass. This, according to M. Ch. Gaillard, is best prepared as follows:—2 parts of gallic acid, 2 parts of quick lime, and 5 of glucose are dissolved in 650 parts of distilled water; when filtered, this forms the reducing solution: 20 parts of nitrate of silver and 20 parts of solution of ammonia are then added to 650 parts of distilled water, and this second solution is also filtered. Immediately before use, equal volumes of the two solutions are mixed together, and constitute the bath into which the silvered fabric is to be immersed to receive a more solid deposit of the metal. After immersion, the materials are washed in a boiling solution of cream of tartar, and subsequently in water; they may then be dried.

In France, M. Burot has produced cloth of gold, and effected the gilding of various textile materials by the following process:—A deposit of silver is first obtained by immersing the material in an ammoniacal solution of nitrate of this metal, drying, and passing over it, in a closed vessel, a current of pure hydrogen gas, which reduces the silver salt. Thus silvered, the fabric is transferred to the electrotype cell, and gilt, with almost as much facility as would be a sheet of wire gauze, by the ordinary method of electro-gilding.

THERMO-ELECTRICITY.

We have seen that, when the electric current meets with obstruction to its course, the equilibrium of heat is disturbed even in good conductors; it might, therefore, have been *à priori* expected that a disturbance in the equal flow of heat would produce an electric current in such forms of matter as are capable of transmitting it.

We are indebted to Professor Seebeck of Berlin, for the experimental confirmation of this conclusion in 1822, and the discovery of the phenomena of Thermo-Electricity.

If a platinum wire be carefully soldered to the two extremities of a delicate galvanometer, and it be heated at any point remote from the junctions, no disturbance of the electric equilibrium will be produced; from the homogeneous structure of the wire, the heat will flow equally to the right and left of the heated point. But it will be very different if a knot or a spiral turn be made in the wire without breaking it; for if the focus of heat be applied to the right of such obstruction, an electrical current will be established from right to left, and will be indicated by the needle. This must arise from the unequal rate at which the heat will obviously be propagated on the two sides of the obstructing mass. Wires of copper and silver will act in the same way, only in a very inferior degree. The same effect will be produced if the wire, instead of being continuous, be divided, and each end being twisted into a spiral to increase the surfaces, one be heated red in a spirit lamp and brought into contact with the other. The deviation of the magnetic needle will indicate as before, that a current is passing from the hotter to the colder point. That these effects do not depend upon any chemical action of the air, is proved by performing the experiment under the surface of well purified oil, under which circumstances the same results will be obtained.

Those metals which possess a decidedly crystalline texture present even more marked electrical phenomena from the unequal propagation of heat in their masses. If a ring or rectangle be cast of antimony or bismuth, of the diameter of three or four inches, and of the substance of about the third of an inch, and one half of its surface be kept cool by ice and the other heated, a current of electricity will be immediately established of sufficient power to affect the magnetic needle without the assistance of a coil.

These thermo-electric effects, again, are very much increased by combinations of two metals. If a bar of antimony have a copper wire soldered to it, or merely twisted round one of its ends, and attached to the other in the form of a loop, when heated at the contact of the metals at one extremity, it will strongly deflect a magnetic needle placed above or below it.

It is found that similar circuits may be formed of combinations of other metals, and that they may be ranged in the following order according to their thermo-electric efficiency; the most powerful combination being formed by those metals which are the most distant from each other in the series:—bismuth; platinum; lead; tin; copper, or silver; zinc; iron; antimony. When heated together, the current is found to proceed from those which stand last to the first.

There can be little doubt that the specific heat and conducting power of the metals must be concerned in these effects; but in comparing the tables of each, the connection does not immediately appear. Structural crystalline arrangement has also much influence upon them. With some combinations, as for example, zinc and silver, the current will go on increasing with the temperature to a certain point, 248°; will then become null, and, by increasing the heat, will be re-established in the contrary direction. This singular phenomenon is most probably referrible to a change in the arrangement of the particles of the zinc.

The different powers of the currents from different couples of metals, for the same differences of temperature, may be ascertained by forming a compound circuit of all those which it is wished to compare. All the junctions are kept at the temperature of melting ice, except that which is to be thrown into activity, which may be raised by being plunged into hot oil. The mere conducting power of the circuit thus remains the same in every experiment, and the results will be strictly comparable with each other.

Similar circuits may also be formed, according to the experiments of M. Nobili, with substances whose conducting power is lower than that of the metals. He made small cylinders of porcelain clay, of the length of two or three inches, and three or four lines in diameter, and wrapped round the ends of each some cotton steeped in a conducting liquid which served to place them in direct communication with the galvanometer. One of the ends was reduced to a point, and after heating it red at a spirit lamp, he pressed it upon the cold extremity of the other cylinder, and a current was established from the hot part of the arrangement towards the cold. This effect is owing to the mutual reaction of two portions of water of different temperatures.

The following table exhibits the quantities of the currents for a difference of 36°, of pairs of eight metals differently arranged; the lengths of which were 7·88 inches, and their diameters about two

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hundredths. The sign + indicates the metal from which the current proceeds :—

THERMO-ELECTRIC POWERS OF DIFFERENT METALLIC COUPLES.

	Temp. of Junction.	Deviation of Needle.	Intensity of Currents.
+ — Iron and Tin . . .	68°	36°·50	31°·24
+ — Copper and Platinum .	68	16·00	8·55
+ — Iron and Copper . .	68	34·50	27·96
+ — Silver and Copper . .	68	4·00	2·
+ — Iron and Silver . . .	68	33·00	26·20
+ — Iron and Platinum . .	68	39·00	36·07
+ — Copper and Tin . . .	68	7·00	3·50
+ — Zinc and Copper . .	68	2·00	1·00
+ — Silver and Gold . . .	68	1·00	0·50

The thermo-electric current may be increased by forming a compound circuit. and arranging the pairs of metals in a series of alternations analogous to those of the voltaic pile. If three bars of bismuth with three of antimony placed alternately, so as to form the sides of a hexagon, be soldered together and placed upon two supports in a horizontal position, one of the sides being in the magnetic meridian with a compass needle below it, upon heating one of the junctions, the needle will be sensibly affected. The deviation will be considerably increased on heating two of the alternate angles of the hexagon; and a still greater deviation will be produced when the heat is applied to the three alternate angles.

In all these combinations, similar effects may be produced by reducing the temperature of one or more of the junctions by the application of ice or other means; and when the action of ice on one set of the alternate angles, is combined with that of flame on the other set the effect is still more considerable. Upon multiplying still further the number of alternations, it is, however, found that the total effect is inferior to the sum of the effects which the same elements could produce when employed in the formation of simple circuits. This is owing to the low state of intensity of the current, which occasions great loss of power, whenever it has to traverse any considerable line of conductors even of the most perfect kind.

The thermo-electric pile has lately been applied by Messrs. Nobili and Melloni, as a most delicate and accurate measure of temperature. Thirty-six pairs of bars of bismuth and antimony, packed into a small compass, and having a very delicate galvanometer with two needles attached to them, were found to be so sensible as to be affected by the warmth of the hand at the distance of thirty feet, and an instrument constructed upon this principle, with all the necessary precautions, is applicable to a variety of delicate investigations for which any of the common thermometers would be totally insufficient.

The thermo-electric current will occasion convulsions in the limbs of a frog, but is inadequate in its primary state to effect any kind of chemical decomposition.

M. Pouillet has compared together the thermo-electric and the hydro-electric currents, by passing the latter through a platinum wire of sufficient length to reduce it to an intensity just sufficient to balance the former. In one of his experiments he found that 590 feet of platinum wire, ·006 inches in diameter, comprising the resistance of the battery previously determined in this measure, were required to reduce the current from twelve pair of plates with double coppers to an equilibrium with that of one pair of bismuth and copper, in a circuit of 65·6 feet of copper wire of 0·039 inches diameter, with a difference of 76° Fahrenheit of temperature.

By calculating, from supsequent experiments, the relations between the electromotive forces and the resistance, in these two cases he ascertained that the hydro-electric current had an intensity 114,000 times greater than that of a single pair of bismuth and copper, produced by a difference between the two junctions of 1·8° Fahrenheit.

We are now prepared to examine more accurately the effect which the electric current produces upon the temperature of good conductors, when it passes from one metal into another in the same circuit. We have already seen that when traversing a compound wire of platinum and silver, the alternate links of the former metal become red-hot, whilst those of the latter remain dark and comparatively cool: this effect we ascribed to the difference of the conducting power of the two metals. If a weak current from a single circuit be transmitted through a bar of equal lengths of bismuth and antimony soldered together, from the bismuth to the antimony, heat is evolved at the point of junction, but if in the contrary direction, from the antimony to the bismuth, an absorption of heat, and consequent depression of temperature, will take place. The effects are appreciable by a delicate thermometer, the ball of which may be placed in a hole drilled in the bar at the point of junction, and it will rise in the first case 80° Fahrenheit, and sink in the second 6·5° Fahrenheit. If the bar be laid upon melting snow, and a little water be placed in the cavity made for the thermometer, it will be completely frozen in a few minutes.

This production of cold by the voltaic current may be demonstrated also in a striking way by the secondary thermo-electric current which it tends to generate. Let a bar of bismuth 4½ inches long, 0·4 inch square, and a similar bar of antimony, be placed across each other at right angles, and mortice half their thicknesses into each other at the place where they cross, and solder them together with tin. On connecting two of their ends with a galvanometer, and sending a current through the others, a deflection of the needle will take place on one side from the current generated by the change of temperature; when the direction of the current is reversed the needle will be deflected in the contrary direction, proving that an opposite change of temperature has taken place from the reversal of the current. That this secondary current is not due to any diversion of the primary current, may be proved by connecting the two ends of the same bar with the galvanometer, and sending the current through the other bar, when no effect will be produced.

These effects of what may, perhaps, be designated as *electro-thermancy*, which we owe to M. Peltier, are the converse of those of thermo-electricity.

There is another well-established and remarkable effect of the heating power of the voltaic current, which is as yet unexplained. When the conducting wires from the two extremities of a powerful battery cross one another, and are brought in contact, upon separating them to a short distance, a flame will appear between the two, and the zincode, or electrode connected with the conducting plate of the battery, will become red-hot, and that connected with the generating metal will remain dark, and comparatively cool. This effect is constant, of whatever metal the conducting wires may be made.

The power of fusion by the electrical flame is greatly influenced by this circumstance, and metals laid upon charcoal in connection with the zincode, melt much more readily when the flame is directed upon them from the platinode, than when their situation is reversed. The constant battery of 70 cells before referred to, completely fused the most refractory metals, when thus disposed: and platinum, rhodium, titanium, and iridium, were melted in considerable quantities.

ON THE DISCOVERY OF THE METAL THALLIUM.

By William Crookes.

(Read at the Royal Institution of Great Britain, Friday, March 27, 1863.)

So many brilliant discoveries have been announced to the world in this theatre, that it was with some diffidence I acceded to the request of the learned secretary of this Institution to relate to you to-night the history of the discovery of thallium. The discovery of a new metal is no novelty in this century. Since its commencement our acquaintance with the material world has been enlarged by the discovery of no less than thirty-two of these elements, and the particular and especial interest with which the three latest additions are regarded attaches as much perhaps to the means by which their existence has been revealed to us as to the metals themselves.

Some of the bodies called metals have been known as such from the earliest times. We have no record nor knowledge of the first discovery of the seven ancient metals—gold, silver, iron, copper, mercury, lead, and tin. I may remark, however, that they are metals which are either found native, or such as are easily separated from their ores by the agency of heat alone, or by the simplest chemical means. Of the rest I may briefly say that a large majority were first discovered by the employment of what I may call exclusively chemical methods. The exceptions to this rule are those whose discovery makes the early part of this century a marked epoch in the history of chemistry and ot this Institution. These are the alkaline and earthy metals first obtained by Sir Humphrey Davy by means of voltaic electricity. I need not detain you now by dilating on the great impulse which the

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employment of this force in the decomposition of suspected metallic compounds gave to the progress of chemistry, and the fruitful results which have attended its use. No means have been attended with such brilliant and useful results until the researches of Bunsen and Kirchhoff definitively applied spectrum analysis to the recognition of elementary bodies.

You have heard and seen so much of the spectrum this season, that it might almost require an apology for introducing the subject once more, were it not that the discovery of thallium is inseparably associated with this method of analysis.

I may here point out one peculiarity with regard to the metals discovered by this method. It is this: that whereas in the case of most bodies discovered in other ways some compound of them was known and the metallic nature of the base was suspected; or some particular reaction had before convinced the discoverer that he had a body endowed with hitherto unrecognised properties in his hand; yet in the case of spectrum analysis, no knowledge or suspicion of the metals themselves, or of any compounds, existed until, as I may say literally, they were first brought to light. The fact of their existence then flashed upon us at once.

A curious historical parallel may be mentioned in connection with the discovery of thallium; and here I must ask to be excused a more frequent use of the pronoun I (which I make with reluctance, and to avoid periphrasis) than is generally heard in lectures of this kind.

The discovery of thallium is strictly analogous to that of selenium by the great Swedish chemist Berzelius.

In each case the original source was some residue from a sulphuric acid manufactory burning pyrites. From some unexplained reaction the presence of the rare element tellurium was suspected. Further examination led to the discovery, by Berzelius, of the element selenium, whilst in my own case the result of the investigation was the discovery of thallium.

Had spectrum analysis been known at the beginning of this century, there is no doubt that Berzelius would have added thallium to the other elements which he was the first to isolate; for I do not hesitate to say that without this powerful means of research thallium would have remained unknown at the present time. The residue was from a manufactory at Tilkerode, in the Harz, and had been placed at my disposal, in 1850, by Professor Hofmann, for the purpose of extracting the selenium from it. This was effected in the ordinary way, and the crude selenium was purified by distillation in hard glass retorts. A considerable residuum was left behind in this operation, and as a few tests seemed to show that tellurium was present in this residue. it was set aside for further examination. Early in the year 1861, happening to require some tellurium for experimental purposes, I sought for this residuum, and examined it more minutely for this element, but without getting very definite results. The chemical tests seemed to give contradictory evidence, when, not succeeding in meeting with tellurium where there were many chemical reasons for suspecting its presence, I had recourse to the spectroscope. I expected to see a system of fine, nearly equidistant, bands of light and shade traversing the spectrum, but instead of this a single brilliant green light flashed across the field of view. [The spectrum of thallium was then projected on the screen, its remarkable green band appearing like an incandescent bar upon a perfectly dark background. The metal being placed between the carbon poles of a forty-cell Grove's battery.]

The chemical treatment through which the substance examined had passed was such as to preclude the possibility of other than the elements antimony, arsenic, osmium, selenium, or tellurium being present, and I well knew that none of these bodies gave a spectrum in any way similar to this. I was therefore convinced that a hitherto unrecognised element was present, and at once devoted myself to the task of isolating it. It would weary you were I to recount the numerous experiments made with this object. The whole amount of the original seleniferous deposit which I had at my disposal was not more than three pounds in weight, and later analysis have proved that the total quantity did not contain more than three grains of thallium. The invaluable assistance afforded by the spectrum test at last enabled me to announce definitely that I was dealing with a new element, and to give a sufficient number of its reactions to show that its chemical properties were well marked and perfectly distinct from those of all other known bodies.

At first I had doubts as to the chemical position of the new body, and, arguing from the reactions I had then ascertained, I was rather inclined to class it amongst the metalloids or semi-metals. After some months' labour, Dr. Thornthwaite, in the most generous manner, placed at my disposal two cwt. of sulphur, likewise containing about one grain of thallium per pound. With this I was enabled to prosecute my experiments, and before long had isolated the metal not only in the form of a black powder by the action of zinc, but in distinct metallic crystals by voltaic precipitation: all doubt as to the actual metallic character of the element now disappeared.

I had already decided upon a name for the new body. With the assistance of a friend, a skilful linguist, the word thallium was chosen, from the Greek θαλλὸς (a green twig), which seemed to recall the green line of its spectrum, and to be adapted for the requirements of chemical nomenclature better than malachium, smaragdinum, viridium, and others which were thought of. The name thallium was at once adopted by the scientific world as appropriate.

Whilst speaking of the metallic nature of thallium, it becomes a duty no less than a pleasure to mention that M. Lamy, a very skilful Belgian chemist, who had been fortunate in meeting with a rich source of the new body in May last, has, independently of my own researches determined its metallic nature, and obtained it in considerable quantity. M. Lamy's specimen of thallium was exhibited to a large meeting of scientific gentlemen of all countries soon after the opening of the International Exhibition, and naturally excited great interest among them. It was afterwards placed in the Exhibition building, where, however, amid the splendours with which it was surrounded, it scarcely attracted the notice it deserved.

I first obtained the metal in crystals by voltaic action in September, 1861, and, although I have since witnessed the operation many hundreds of times, I know of no other experiment of a similar kind which can at all compare with it in beauty.

I have arranged on the table a small apparatus in which the crystallisation of thallium is now proceeding under the influence of two or three cells of Grove's batteries. By the end of the lecture I have no doubt you will find that the bottom of the dish will have become almost covered with beautiful metallic crystals.

In order to render this visible to all my audience, I have placed some of the same solution of sulphate of thallium in a small glass cell containing the platinum terminals of two Grove's batteries. I will endeavour to project an image of these poles on the screen by means of the electric microscope, during electrolysis. In an experiment of this kind, in which I cannot detain you many minutes, some of the beauty and delicacy of the forms must necessarily be sacrificed to rapidity of crystallization; but still I think you can all see the slender branches and fern-like vegetation in which the metallic crystals are shooting across the liquid.

Thallium comes down with such ease from its solutions under voltaic influence, that I now invariably adopt this plan for reducing it in the first instance, in preference to precipitating it with metallic zinc.

In order to obtain the metal in the coherent form, it is now only necessary to squeeze it together and fuse it under cyanide of potassium when it is obtained in the form of on ingot,

Hitherto I have been working under great disadvantages, owing to my small stock of material; each experiment requiring nearly the whole of my scanty store, which had then to be worked up again into an available form for the next experiment, causing great and unavoidable sacrifice both of time and material. Thanks, however, to the munificence of the Royal Society, my investigation will no longer stop for want of material, and I am now in communication with Mr. Spence, one of the largest burners of thalliferous pyrites in this country, who has, in the most handsome manner, offered to alter his flues, so that the greater portion of the thallium, which is now lost in the sulphuric acid, may be saved.

And now, having finished the history of the discovery of thallium, I shall follow the plan usually adopted in describing metals. And first as to the source. Up to the present time, the only available one is iron pyrites, such as is used largely, both in this country and on the continent, for making sulphuric acid. I have here before me a few specimens of one of the richest thalliferous pyrites which I have yet met with. It is brought from Belgium, and is largely used, both here and abroad, in the manufacture of sulphuric acid. The mineral being burnt in properly-constructed furnaces, the volatile products of its combustion are passed into large leaden chambers, where the sulphurous acid is mixed with nitrious vapours and steam, and becomes converted into sulphuric acid. Now, when the sulphur of the iron pyrites is burnt the product is a gas, and when the thallium contained in the pyrites is burnt the product is a volatile solid. By reason, however, of the great excess of sulphurous acid, and its high temperature (owing to the proximity of the leaden chamber to the furnace), nearly the whole of the thallium is carried through into the lead chamber, where it dissolves in the dilute sulphuric acid, forming sulphate of thallium, a soluble salt. In this case the thallium is lost, for it would be a most tedious and expensive operation to extract it from the acid, which, indeed, is no richer in thallium than the original ore. Thallium may, however, be readily *detected* in many samples of crude oil of vitriol, as well as in

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commercial products and chemicals which are made from it. Thus, the very common yellow hydrocloric acid, worth about 1d. per lb., often contains it. I have here a bottle of this acid, obtained from Messrs. Chance, Brothers, of Birmingham, and in this tube [exhibiting a pecimen tube] I have a lump of pure metallic thallium, which I prepared from one cwt. of the acid. Owing to the imperfect means adopted to isolate the metal much of it was lost, but the piece actually obtained weighs upwards of five grains.

Let me also draw your attention to some of the other thalliferous substances which are on the table before. Here is a fine specimen of cake-sulphur, some sulphide of cadmium, metallic cadmium, and metallic zinc, all from Nouvelle Montague; a large ingot of Spanish copper; some sulphur, also from Spain; specimens of bismuth ores, with precipitated carbonate of bismuth, also thalliferous, recently purchased at a druggist's; commercial sulphate of copper, some pieces of selenium, and a quantity of metallic tellurium, in which thallium is present rather largely. There is also a large collection of thalliferous pyrites from all parts of the world, and a small specimen of native sulphur from Lipari, said to contain selenium, but which I have found so rich in thallium, that it deserves to be classed as a new mineral.

I have given you a brief outline of the path followed by the thallium in most of our sulphuric acid works. Fortunately in some manufactories a slight modification is adopted, which permits of the accumulation of this metal in the flues. Instead of the sulphurous acid, &c., going direct from the furnace into the lead chambers, it passes through a greater or less length of flue, where the temperature becomes lowered sufficiently much of the thallium and other solid volatile matter (*e. g.*, mercury and arsenic) which it may contain. In this *flue-dust*, as it is called, I have frequently detected thallium, and in some instances in sufficient quantity to render its extraction well worth undertaking. In M. Kuhlmann's works at Lille the products of combustion of the pyrites are passed first into a supplementary chamber, where they are cooled down, and deposit nearly the whole of the thallium, arsenic, &c., before entering the converting chambers. This accounts for the richness of the deposit employed by M. Lamy for his researches.

The richest pyrites which I have yet examined have yielded me no more than ten ounces of thallium to the ton of ore. This may seem too minute a proportion to be worth noticing; but in 1,000 tons it amounts to nearly 6 cwt., and as 8 or 10 tons of ore are burnt daily in some of our largest vitriol works I do not think I was exaggerating when I said, nearly a year ago, that thallium was in some works being thrown away by the hundredweight, the whole of which might be saved if manufacturers could be induced to modify their flues so as to effect its proper condensation.

Through the kindness of Professor Chandelon, of Liège, two tons of thalliferous pyrites from the Société Anonyme de Rocheux et d'Oneux, Theux, were placed at my disposal. After considerable delay, this arrived at my laboratory in September last, and from that time almost to the present I have been constantly engaged in extracting the thallium from it.

The first operation consists in breaking up the pyrites into lumps the size of a walnut, and distilling the sulphur from it. For this purpose hexagonal iron pipes, closed at one end, are arranged in a reverberatory furnace, five at a time, so that the flame can lick round and raise them to a bright red heat. Each retort contains 20 lbs. of mineral, and has an iron tube receiver luted on to the end of it. After some hours' heating the operation is terminated, and the receivers contain from 14 lbs. to 17 lbs. of dark green or grey-coloured sulphur from each cwt. of ore. Several large cakes of this are on the table. This appears highly thalliferous when examined by the spectrum test, but when treated chemically I have not succeeded in obtaining a larger yield from it than 10 grains of thallium per pound of sulphur.

The separation of the metal from this sulphur is a matter of some little difficulty to one unprovided with the resources of a manufacturing laboratory. Indeed, I should have been quite unable to show you such pieces of thallium as I have here to night, had not Messrs. Hopkin and Williams, the well-known manufacturing chemists, undertaken to perform the subsequent operations in their well-appointed works at Wandsworth. In less time than it used to take me in my private laboratory to work up ten pounds of sulphur, they have prepared for me the chloride of thallium from two cwt. The process adopted is briefly as follows;—The sulphur is powdered and boiled in a large iron pan with a solution of caustic soda until it has all dissolved, with the exception of a black precipitate suspended in the liquid. After cooling, it is filtered, washed, and the precipitate boiled in sulphuric acid. When all has dissolved that will, it is filtered, and hydrochloric acid is added to the filtrate, which determines the formation of the difficultly soluble protochloride of thallium. This is filtered off, washed once with dilute hydrochloric acid (in which it is less soluble than in pure water), and converted into sulphate. From the solution of this salt the metal is precipitated by voltaic electricity, as is now in operation on the table.

In order to obtain this spongy thallium in the coherent form it is not even necessary to fuse it. There is in this bottle of water a quantity of metallic sponge—the results of this day's precipitation in my laboratory—I merely have to knead it into a lump between my fingers and then put it into a steel crushing mortar, without even taking the trouble to dry it. I now submit it to powerful pressure in this vice, and you see that I have produced a brilliant metallic-looking ingot, perfectly solid, as can be told by the sound when thrown on the table.

Well, now, having obtained the thallium, let me draw your attention to its chief characteristics, wherein it agrees with or differs from its fellows. It is a white, opaque metal, endowed with a perfect metallic lustre, as may be seen at the close of the lecture by examining the beautiful crystals now being deposited all over the bottom of this dish. Metals are usually divided into two classes, *light* and *heavy;* thallium certainly belongs to the heavy metals, not only on account of its specific gravity, which is 11·9, a trifle higher than that of lead, but also for other reasons which I shall come to presently. It is very malleable, and may readily be rolled into leaves as thin as tissue paper, as shown by the specimen of foil before you. It is not very ductile, and can only be drawn into wire with great difficulty. By employing pressure, however, thallium wire can be made with the utmost facility. I have here a small hollow steel cylinder, with a piston fitting tight into it; at one end is a very fine hole, and upon filling the cylinder with thallium, and forcing in the piston by means of the vice, the thallium issues out through the fine hole in the form of wire. I have arranged an apparatus here by which the wire as it issues from the cylinder is conducted along a glass tube into a specimen bottle, a current of dry carbonic acid passing through the apparatus all the time. By means of the electric light I project the image of the specimen bottle on to the screen, and upon giving one or two turns to the screw of the vice you perceive the wire issuing forth and curling up in folds like a thick rope. The bottle is now filled with the coil of wire, and if I cement the stopper in, the specimen will preserve its metallic lustre and brilliant surface unchanged.

Thallium is very soft, in fact it is the softest known heavy metal, being only exceeded in this respect by the alkali metals. A piece of lead scratches it, as you perceive, with the utmost facility, without itself receiving an appreciable impression. It also possesses the property of welding together in the cold by pressure. I can illustrate this by taking another steel cylinder and filling it with several pieces of metallic thallium. (Fourteen pieces were put in.) A turn of the vice forces it out, as you see, into one solid rod, which, upon examination, will be found just as continuous and coherent as that made from one lump.

Thallium marks paper like plumbago, forming a streak having a yellow reflection. The mark almost entirely fades out in a short time from oxidation. A week ago I wrote a word upon this sheet of paper; upon close examination I can just read it, but I do not think it is visible to any one else. I have, however, merely to pass over it a sponge which has been dipped into sulphide of ammonium, when the word THALLIUM appears black, and visible to all.

The electrical conductibility of thallium has been recently examined by Dr. Matthiesson, to whose instruction I am indebted for the wire-making process just shown. He finds it near lead in this respect. His researches were communicated to the Royal Society a few weeks ago.

The magnetic relations of thallium are very interesting. Professor Faraday has been good enough to arrange an experiment by which its behaviour under the magnetic force can be rendered clearly visible to all in the room. A small sphere of thallium is fastened to the short end of a light wooden lever, a square index of white paper being at the other extremity. The lever is suspended horizontally by some long threads of cocoon silk in such a way that the sphere all but touches one of the conical poles of the large electro-magnet belonging to this Institution. I now pass the current of forty Grove's batteries round the electro-magnet, when you see, from the large arc travelled over by the paper index, how violently the thallium sphere is repelled from the pole of the magnet. It is, in fact, next to bismuth, the most diamagnetic metal known.

Thallium is easily fusible, melting at a temperature of 550° Fah.; at a full red heat it may be distilled, but it begins to evolve vapours at a lower point. If I heat a piece on charcoal before the blowpipe, you perceive the metallic vapours flying off copiously, colouring the flame a rich green. The colour which it communicates to flame is better shown by holding, in a colourless gas flame, two or three platinum wires having an alloy of thallium and platinum fused on to their

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ends. I will place by the side of this, other two flames coloured respectively with barium and copper, when you can judge of the extreme richness and purity of the thallium green by the manner in which it appears to kill the others.

Thallium burns brilliantly in oxygen, and small fragments of the metal also take fire when thrown into a gas flame, giving rise to an intense green light. Exposed to the air it tarnishes very quickly; indeed, with almost the rapidity of an alkali metal, becoming coated with a film of oxide, yellow at first, and gradually darkening. This oxide is tolerably soluble in water, forming a highly alkaline solution. It, however, differs radically from potash and soda, and closely approaches oxides of silver and lead (which are, likewise, soluble and alkaline), in having scarcely any affinity for water; it being rendered anhydrous even at the ordinary temperature in a vacuum. I can illustrate the alkaline character of its oxide by taking this ingot of thallium, and rubbing it across a piece of moistened turmeric paper on a white plate. Wherever the thallium has touched a brown mark is produced. If I apply the tarnished surface of the metal to the tongue it tastes very caustic and biting, and somewhat metallic. When I place a piece of tarnished thallum in water, the superficial film of oxide dissolves, and exposes a bright surface of metal. Hot water cleans it at once, and renders the surface crystalline, like tinplate washed with acids. If the thallium be quite pure, and the water free from air, no sensible action appears to be exerted on the metal, but when exposed to the joint action of air and water it is gradually oxidized. Curiously enough alcohol acts upon it more than water does. The soluble oxide (the protoxide) is also formed very rapidly when thallium is melted in the air; it then fuses like litharge, and is absorbed in the same manner into a bone-ash cupel. When thallium burns in oxygen a peroxide is formed.

Thallium dissolves in acids, its proper solvent being nitric acid; it forms two if not three basic oxides and an acid oxide. The salts of the protoxide are the only ones which have been much studied. They are a well-defined series, most of them being beautifully crystalline. Many of these compounds have been very skilfully investigated by MM. Lamy and Kuhlmann, jun. Some of the proto-, sesqui-, and per-salts are on the table, as also one or two thallates. Let me especially draw your attention to the beauty of the crystallized sulphate, nitrate, and chlorate of the protoxide, the yellow sesquichloride in glistening spangles, and this large bottle full of the proto-chloride, upwards of a pound in weight.

On the table before me I have arranged three series of test glasses, the upper row containing protosulphate of thallium, the middle row nitrate of silver, and the bottom acetate of lead. To these I will apply the ordinary tests used in chemical analysis, and I think there is no doubt that my chemical friends who are present will admit with me that the true position of thallium is by the side of these two metals, and not, as M. Dumas and other French chemists affirm, in the potassium and sodium group.

Gas light not being very well adapted for showing shades of colour, I have arranged to illuminate the table with electric light during these tests. I first add hydrochloric acid to the solutions, a white precipitate falls in each case: the protochloride of thallium being scarcely distinguishable from chloride of silver: it is, however, slightly soluble in water. Iodide of potassium gives a yellow precipitate with each metal. Bichromate of potash a yellow precipitate with thallium and lead, and a red one with silver. Sulphocyanide of potassium gives white, and sulphide of ammonium black precipitates in all three metals. Bichloride of platinum produces an insoluble double salt with thallium, and precipitates the silver and lead as chlorides. Ammonia produces no change in the thallium solution: gives a precipitate with silver which redissolves in excess, and permanently precipitates the lead salt. Sulphuretted hydrogen has likewise no action on the thallium salt, but precipitates the other two. When, however, I add ammonia to the thallium after addition of the sulphuretted hydrogen, a black precipitate is produced, and finally sulphuric acid produces (of course) no change in sulphate of thallium, a slight crystalline precipitate in nitrate of silver, and a dense white one in acetate of lead. From these tests you therefore perceive that whilst the similarities between the three metals are very great, there are, nevertheless, characteristic differences, though not greater than between most nearly allied metals.

I have only time to show two reactions with solution of sesquichloride of thallium: the first is the precipitation of the slightly soluble protochloride upon addition of sulphite of soda, and the second the formation of a brown peroxide and precipitation of protochloride in crystals upon addition of ammonia. This latter reaction is a very curious one.

Let me, in conclusion, say a few words respecting the position of thallium amongst elementary bodies. In classification observers generally err in regarding natural bodies as so many links in a perfect chain, and facts are frequently strained in order to make them agree with this preconceived opinion. In such a group as chlorine, bromine, and iodine, we have, doubtless, three consecutive links; but most frequently Nature should be looked upon more as a perfect net than a perfect chain. In seeking for the chemical relationships of thallium, it is found that this metal occupies a somewhat anomalous position, being well described by an eminent French chemist as the ornythorynchus of metals. At first sight it might appear to belong to the group of alkali metals, on account of its forming a readily soluble, highly alkaline oxide; it likewise forms an insoluble platino-chloride, which also renders it analogous to some of the alkali metals, although not to others; but, on the other hand, its physical characters, its chemical reactions, and its high atomic weight (about 203) prove incontestably that the true position of thallium in the scale of elements is close to lead and silver.

In these utilitarian days a discoverer must be prepared to give some kind of answer to the question,—"What is the use of it?" Now, the possible uses of a body depend chiefly on its abundance, and as soon as thallium is procured by the ton at no greater cost than it is now by the ounce, it will certainly be utilized in many directions. In the pure metallic state it probably tarnishes too readily, and is too quickly acted upon by atmospheric agencies for it to possess much practical value in this form. In the form of alloy, however, its uses are likely to be very great, as it readily mixes with many metals, and communicates to them valuable properties.

The magnificent green which it communicates to a flame at once suggests a valuable application of thallium for pyrotechnic purposes. At the ordinary temperature of flame, the thallium light is absolutely homogeneous, and even at the high temperature of the electric arc, the other lines, which Dr. Miller has shown are produced, and which I have attempted to copy on this diagram, fade before the brilliancy of the characteristic green line.

Perhaps the best way for me to show the magnificent green light evolved by incandescent thallium vapour is by projecting on the screen the highly magnified image of the thallium electric arc. I have scooped out the lower carbon of the electric lamp into the form of a small cup, and, upon placing ten or a dozen grains of thallium in it, and making contact, the upper pole can be separated for a space of an inch or more, voltaic connection being maintained by the bridge of thallium vapour rising from the cup. The image of this on the screen fills up a space of twelve inches or more with absolutely monochromatic green light, and if I introduce into this green space variously-coloured bodies, a bouquet of bright flowers, or even my own face, you will see the strange changes it produces in the apparent colours of bodies, everything being either green or black, like as in the sodium flame every object is yellow or black.

The reason why the homogeneous light given by sodium and thallium is so intense is owing to all the luminiferous energy of the element being concentrated into one ray, instead of being diffused over different portions of the spectrum.

These experiments show that thallium is pre-eminently the pyrotechnic element; but regarded for the present merely from a scientific point of view, its early history will always be looked upon with interest, as proving the beauty and accuracy of spectrum analysis, and the striking manner in which the deductions therefrom have been confirmed.

ON THE LONG SPECTRUM OF ELECTRIC LIGHT.

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(Continued from p. 256.)

Metallic Lines.—These may be viewed, as already mentioned, by passing the spark of an induction coil between two electrodes formed of the metal to be examined (the secondary terminals being respectively in connection with the coatings of a jar of suitable size), forming a pure spectrum by a prism and lens of quartz, the faces of the prism being equally inclined to the axis of the crystal, and the lens being cut perpendicular to the axis, and receiving the spectrum on a suitable screen, for which, if a fluorescent liquid be employed, it is to be placed in a quartz-faced vessel, in default of which a piece of filtering-paper may be saturated with the liquid.

If the visible spectrum and the very beginning of the invisible be excepted, the lines thus seen vary from metal to metal, and therefore are to be referred to the metal and not to the air. They are further distinguished from air lines by being formed only at an almost insen-

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sible distance from the tips of the electrodes, whereas air lines would extend right across. The spectrum is far too extended to allow us to regard the whole at once as in the position of minimum deviation; and if the prism be placed at all near the electrodes, without which we should have comparatively little light to work with, the effect of the different divergency, converted by lens into convergency, of the rays in the primary and secondary planes is very great. In order to obtain a pure spectrum, the screen must be in focus as regards the primary plane; and if a particular point P of the spectrum be at a minimum deviation, the lines immediately about P are reduced almost to points, which are the images, for light of that refrangibility, of the tips of the electrodes, or, to speak more exactly, of the part of the spark just outside the tips. But in the secondary plane the rays on one side of P have not yet reached their focus, and on the other side have passed it; so that the image of a point is a line, the primary focal line, of a length increasing on receding from P in either direction, and accordingly the spectral image of either tip, assumed to be a mere point, would be a pair of slender triangles vertically opposite, and having their common vertex at P, their lengths lying in the plane of refraction. The invisible spectrum is in fact made up of two such pairs of triangle corresponding to the two tips respectively, as may be readily seen when the electrodes are not too close. At a distance from P, at which the length of the primary focal line becomes equal to that of the image of the spark the two lines which are the images, for rays of the refrangibility answering to that distance, of the tips of the electrodes meet in the middle of the spectrum, and beyond that distance they overlap, so that a line appears to run across the spectrum, though it relates to rays which emanated only from the immediate neighbourhood of the tips of the electrodes, as may be seen by turning the prism till that part of the spectrum is at a minimum deviation, and focussing afresh.

Besides the bright lines, evidently due to metals, which have been mentioned, other weaker light is perceptible, too faint for precise observation. A portion of this is probably due to the air.

The chief part of the visible spectrum, as seen by projection, appears plainly to belong to the air; for the lines stretch across the interval separating the electrodes, while the lines belonging to the metals extend but a little way, even in the visible spectrum, and the former reappear when the electrodes are changed. With some metals, however, lines belonging to the metal appear in the visible spectrum which are comparable in strength with the invisible lines of high refrangibility; but in general it is rather remarkable how poor is the visible spectrum, and even the invisible region for a good distance beyond, compared with the part of the spectrum of still higher refrangibility, with respect to strong lines characteristic of the metal.

I have lately adopted a mode of laying down positions in the invisible spectrum, which is extremely simple and convenient, and yields results agreeing well with one another. It might be applied to the formation of maps of the metallic lines; but this is unnecessary, as the subject has been worked out by Dr. Miller. It is still useful, however, for laying down the positions of bands of absorption, being more convenient and exact than estimating their place with reference to the known metallic lines.

The method is as follows:—The quartz prism is placed on a block, raising it to a convenient height above a long drawing-board, to which the block is screwed, and is fixed at pleasure by a screw pressing upon it from above. The lens is fixed in a blackened board screwed edgeways to the drawing-board near the prism, so as to be ready to receive the rays of all refrangibilities after refraction through the prism. The focal length of the lens actually used was about 12 inches, and its diameter 1¼ inch. A convenient distance of the spark from the prism having been selected (I chose 30 inches), the drawing-board was turned round till it attained such a position that, on placing the prism in the position of minimum deviation for the middle of the long spectrum, the rays belonging to that part fell perpendicularly, or nearly so, on the lens, which had previously been placed so that this should be a convenient position relatively to the drawing-board. The prism was then fixed by its screw, and to mark the angle of incidence a pin was placed at the edge of the shadow of one of the blocks. On account of the increasing refraction by the lens of rays of increasing refrangibility, the locus of the foci of the different rays formed an arc of a curve, or nearly a straight line, lying very obliquely to the axes of the pencils coming through the lens. The projection of this line on the board having been marked, a line was drawn bisecting this at right angles, and at a point in the latter line situated 11¾ inches from the former,* the board was pierced for the insertion of a pivot, which carried two wooden rulers, which could be clamped together at any convenient angle. The shorter of these carried a vertical needle, which as the ruler was turned moved in front of the focus of the different rays at the distance of about a quarter of an inch. The longer ruler carried a pricker, destined to mark on a sheet of paper, temporarily fastened to the drawing-board, the position of any object observed. Thus the prism, the lens, the axis of motion of the needle and pricker, and the pin for fixing the angle of incidence retained an invariable relative position when the drawing-board was moved. In observing, the electrodes were placed at the proper distance, and the board turned till the edge of the shadow fell on the pin. The rulers were then turned together till any bright line or other object was eclipsed by the needle, and its place was then pricked down. To obtain a fixed point of reference, I generally pricked down the position of the extreme red visible on a screen, such as a piece of paper; but if great accuracy were required, it might be better to employ a well-marked green air-line.

The metals the spectra of which I have observed are platinum, palladium, gold, silver, mercury, antimony, bismuth, copper, lead, tin, nickel, cobalt, iron, cadmium, zinc, aluminium, magnesium. Several of these show invisible lines of extraordinary strength, which is especially the case with zinc, cadmium, magnesium, aluminium, and lead, which last, in a spectrum not generally remarkable, contains one line surpassing perhaps all the other metals. Other metals exhibit lines which in certain parts of the spectrum are both bright and numerous; so that, in taking a rough view of the whole, certain parts of the spectrum are bright and tolerably continuous, while other parts are comparatively weak. This grouping of the lines is especially remarkable in copper, nickel, cobalt, iron, and tin. Of the metals mentioned, magnesium gives by far the shortest spectrum, ending in a very bright line, beyond which, however, excessively faint light may be perceived to a distance about as great as the extent of the longer spectra. Aluminium, on the other hand, stands at the head of the above metals for richness in rays of the very highest refrangibility; and it is to this part of the spectrum that the strong lines above mentioned belong. In calling these lines strong, it must be understood that some allowance is made for their very high refrangibility; for when observed as above described they do not appear *absolutely* quite so strong as the bold lines of zinc or cadmium. This is partly due to the defective transparency of quartz, which for this part of the spectrum shows itself by no means perfect; and indeed the highest aluminium line, which is a double line, can only be seen by rays which pass through the prism near its edge.

Besides the lens above mentioned, I sometimes employ in a different manner another of ½-inch diameter and 2½ inches focal length, and accordingly large for its focal length. This is used for forming an image of the spark, which is received on the substance that is to be examined, or that is used for examining the spark. The difference of focal length for the different rays is so enormous that, while one part of the spectrum is in focus, other parts are utterly out of focus, and thus we may judge in a general way of the refrangibility of the rays by which any particular effect is produced. In this way such concentration of the rays is obtained that effects may be studied which would not bear examination by prismatic analysis. In speaking of this lens I shall call it the 2·5-inch lens, from its focal length.

Absorption of the Invisible Rays by Alkaloids, Glucosides, &c.—Before examining these substances, it is requisite to dissolve them, and we must first inquire into the transparency of the solvent. Fortunately, the most useful of all solvents, water, is transparent when pure; and as to reagents, we may employ sulphuric or hydrochloric acid for an acid, these acids being transparent, and ammonia, suppose, for an alkali. In speaking of a substance as transparent, I wish it only to be understood that it is of a transparency comparable with quartz. As to ammonia, although it absorbs the more refrangible rays when in quantity (unless the observed absorption were due to some impurity), it may be deemed transparent in the small quantity which alone it is requisite to employ. Even alcohol, which in the state in which it is to be had is defective in transparency, is sufficiently transparent to be employed as a solvent for such substances as those under consideration, provided it be used in small thickness only.

The alkaloids and glucosides which I have examined are almost without exception intensely opaque for a portion at least of the invisible rays, absorbing them with an energy comparable for the most part to that with which colouring matters (such as alizarine, &c.) absorb the visible rays. The mode of absorption also is frequently, I might almost say generally, highly characteristic; so that by this single property they might be distinguished one from another. It frequently happens, too, that the mode of absorption decidedly changes according as the solution is acid or alkaline, which assists still further in the discrimination.

* A longer distance would have been better.

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In the examination I sometimes employ a small cell with parallel faces of quartz, sometimes a wedged shaped vessel, having its inclined faces also of quartz, but more commonly the former. The cell being filled with the solvent, a minute quantity of the substance is introduced and the progress of the absorption is watched as the substance gradually dissolves, the fluid meantime being of course stirred up. In this way it is easy to seize the most characteristic phase of the absorption, which may be then registered by the pricking instrument. When minima of opacity occur, it is best to seize that stage of the absorption at which they are well developed. When no minima occur, a greater or less part of the more refrangible region is quickly absorbed, after which the absorption creeps on toward the less refrangible side. When once it has become tolerably stationary, the limit of the rays transmitted may be marked. It seems desirable not to go beyond this point in the absorption, lest some possible impurity in the substance examined, which, if it had formed the whole of the specimen would have absorbed rays of lower refrangibility, should begin to make itself perceived, and its mode of absorption should be mistaken for that of the substance professed to be examined.

All the metallic spectra are discontinuous, which prevents the mode of absorption of even a solid or liquid from being observed quite so well as in the solar spectrum, even independently of the greater intensity of the latter, and would greatly interfere with the observation of narrow bands like those shown by the absorption of certain gases in the visible spectrum, and of which chlorous acid gas (ClO_4) shows a splendid system in the invisible part of the solar spectrum. Should a general absorption take place in a part of the spectrum where previously a bright group of lines was seen, with weaker light for some distance on both sides, it is evident that at a certain stage of the absorption the bright group would be left isolated, and the effect might be mistaken for a maximum of transparency. In doubtful cases of this kind, it is requisite to change the electrodes, so as to use the spectrum of some other metal; but practically the difficulty is not so great as might be supposed.

It is desirable to choose a metal which gives a spectrum that is bright and tolerably continuous in the region in which the distinctive features of the absorption are most likely to occur. For general use in the examination of substances such as here considered, I prefer tin —the electrodes (or some of them at least) being broad, for a reason which will be mentioned presently. Tin, indeed, is weak in the most refrangible region, though after a long interval of weakness it shows one pretty strong line between the second and third of the strong aluminium lines; but with these substances the distinctive features of the absorption hardly ever occurs so late. For combined strength and continuity, copper answers well for the highly refrangible region in which tin is weak; while mercury, which may be employed in the form of amalgamated zinc, is the richest metal for the invisible region just beyond the visible spectrum; but I have employed tin almost exclusively.

A glance will show how distinctive is the mode of absorption of the rays of high refrangibility by these different substances. Indeed, this one character would serve to distinguish all these substances one from another, unless it be morphine from codeine and caffeine from salicine. A solution of brucine cuts off the invisible end of the solar spectrum about midway between the lines S and T, and accordingly not far from the end of the region which it requires a quartz prism and lens to see. Accordingly, when these substances are examined by solar light their distinctive characters are almost wholly unperceived, the solutions of some appearing quite transparent, and those of others merely cutting off the extreme rays to a greater or less distance. With æsculine alone the maximum of opacity lies within the solar spectrum; but even in this case we should have little idea of the great increase of transparency about to take place.

The effect of acids and alkalies on all the glucosides referred to presents one uniform feature. When a previously neutral solution is rendered alkaline, the absorption begins somewhat earlier, when rendered acid, somewhat later. With salicine there is merely an indication of this change. falling within the limits of errors of observation; but in the other cases it is quite perceptible, and with phlorizine the shifting of the band of absorption produced by an acid is very large. Fraxine (or paviine) agrees remarkably with æsculine in all its optical characters; the maximum of absorption is merely situated a little nearer to the red, and the tint of the fluorescent light corresponds to a slightly lower mean refrangibility.

Quinine presents no decided maximum of transparency. With this and the other bases observed, with one exception. the absorption. if changed at all, is changed in an opposite manner to the glucosides when the base is set free by ammonia. Bands of absorption occur also with neutral substances, for example, commarine and paranaphthaline, which last exhibits a system of such bands in the invisible part of the solar spectrum.

Aconitine, atropine, and solanine exhibit no bands of absorption, but merely a general opacity for the more refrangible rays. The last, indeed, when dissolved in dilute sulphuric acid, is, for this class of bodies, remarkably transparent; while when the base is set free, the solution, contrary to what takes place with the other bases, becomes much more opaque, but the absorption is vague. I am not sure, however, how far the purity of the specimen examined may be trusted, though it was white, and regularly crystallised. It would be easy to examine more such substances; but what precedes is sufficient to show the value of the study of the absorption of the rays of high refrangibility, as affording distinctive characters of substances little known.

TELEGRAPH BILL.

(*As Amended in Committee on re-commitment, and on second re-commitment.*)

To Regulate the Exercise of Powers under Special Acts for the Construction and Maintenance of Telegraphs.

PREPARED AND BROUGHT BEFORE PARLIAMENT BY MR. MILNER GIBSON AND MR. HUTT.

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, as follows:

Preliminary.

1. This Act may be cited as The Telegraph Act, 1863.

2. This Act shall apply—

To every Company to be hereafter authorised by Special Act of Parliament to construct and maintain Telegraphs:

To every company already so authorised by any such Special Act notwithstanding anything in any such Special Act contained,—but so that, except as hereinafter expressly provided, nothing in this Act shall give to any owner, lessee, or occupier of land, or other person or to any body, as against any such company as last aforesaid, in respect of anything already lawfully done by such company under any such Special Act, any further or other right, power, jurisdiction, authority, or remedy than he or they would have had if this Act had not been passed; and also that nothing in this Act shall interfere with the maintenance or repair, under any such Special Act, of any work already lawfully constructed by any such company under any such Special Act, or shall relieve any such company from any obligation or liability under any agreement already made.

3. In this Act—

The term "the company" means any company to be hereafter authorised as aforesaid (hereinafter distinguished by the term "future company"), or any company already so authorised (hereinafter distinguished by the term "existing company"):

The term "telegraph" means a wire or wires used for the purpose of telegraphic communication, with any casing, coating, tube, or pipe enclosing the same, and any apparatus connected therewith for the purpose of telegraphic communication.

The term "post" means a post, pole, standard, stay, strut or other aboveground contrivance for carrying, suspending, or supporting a telegraph:

The term "work" includes telegraphs and posts:

The term "street" means a public way or street, square, alley or court, whether a thoroughfare or not, situate within a city, town, or village, or between lands continuously built upon, and being repairable at the public expense, or a public highway for carriages, within or passing through a city, town or village, or passing between lands continuously built upon, and being repairable at the public expense, including the footpaths of such way, street, square, alley, court or highway, and any bridge forming part thereof:

The term "public road" means a public highway for carriages, being repairable at the public expense, and not being a street, including the footpaths of such public highway, and any bridge forming part thereof, and also any land by the side and forming part such a public highway, but not including a railway or canal:

The term "railway" includes any station, work, or building connected with a railway:

The term "canal" includes navigation or navigable river, and any dock, basin, towing-path, wharf, work, or building connected with a canal:

The term "land" means land not being a street or public road, and not being land by the side and forming part of a public road, and includes land laid out for and proposed by the owner to be converted into a street or public road:

The term "body" includes a body of trustees or commissioners, municipal corporation, board, vestry, company, or society, whether incorporated or not; and any provision referring to a body applies to a person, as the case may require:

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The term "person" includes corporation aggregate or sole:

The term "the Board of Trade" means the Lords of the Committee of Her Majesty's Privy Council for the time being appointed for the consideration of matters relating to trade and foreign plantations:

The term "justice" means justice of the peace acting for the place where the matter requiring the cognizance of any such justice arises, and not being interested in the matter:

The term "two justices" means two or more justices met and acting together, or any one police magistrate or justice having by law authority to act alone for any purpose with the powers of two justices:

The term "sheriff" means the sheriff depute of the county or ward of a county in Scotland, and the steward depute of the stewartry in Scotland, in which the matter submitted to the cognizance of the sheriff arises, and includes the substitutes of such sheriff depute and steward depute respectively.

4. The provisions of The Railways Clauses Consolidation Act, 1845, with respect to the recovery of damages not specially provided for, and of Penalties, and to the determination of any other matter referred to justices, and the provisions of the Railways Clauses Consolidation (Scotland) Act, 1845, with respect to the recovery of damages not specially provided for, and to the determination of any other matter referred to the sheriff, or to justices, shall, so far as the same are applicable, and save so far as the same are inconsistent with any express provision of this Act, be incorporated with this Act; and terms used in those provisions shall be interpreted as the same terms are directed to be interpreted in this Act.

5. The following provisions shall apply to notices and consents under this Act:—

Every notice or consent shall be in writing or print, or partly in writing and partly in print:

Any notice to or by a body having the control of a street or a public road, or of the sewerage or drainage thereunder, may be given to or by the secretary, clerk, or surveyor, or other like officer (if any) of such body:

Any consent may be given on such terms or conditions (being in themselves lawful), or subject to such stipulations as to the time or mode of execution of any work, or as to the removal or alteration, in any event, of any work, or as to any other thing connected with or relative to any work, as the person or body giving consent thinks fit.

General Powers of Company.

6. Subject to the restrictions and provisions hereinafter contained, the company may execute works as follows:

They may place and maintain a telegraph under any street or public road, and may alter or remove the same:

They may place and maintain a telegraph over, along, or across any street or public road, and place and maintain posts in or upon any street or public road, and may alter or remove the same:

They may, for the purposes aforesaid, open or break up any street or public road, and alter the position thereunder of any pipe (not being a main) for the supply of water or gas:

They may place and maintain a telegraph and posts under, in, upon, over, along, or across any land or building, or any railway or canal, or any estuary or branch of the sea, or the shore or bed of any tidal water, and may alter and remove the same:

But in the exercise of such powers the company shall do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason or in consequence of the exercise of such powers (such compensation to be ascertained, paid, and enforced in manner provided in The Lands Clauses Consolidation Act, 1845, and The Lands Clauses Consolidation (Scotland) Act, 1845, as the case may require, with respect to compensation for lands taken under those Acts respectively), and shall also cause as little detriment or inconvenience as circumstances admit to the body or person to or by whom any such water or gas pipe as aforesaid belongs or is used, and shall not alter the position of any such water or gas pipe, except upon or immediately after the expiration of not less than twenty-four hours' notice given by them to the body or person to whom the pipe belongs; and with liberty for the body to whom any such water or gas pipe belongs, when and as occasion requires, to alter the position of any work of the company under, in, or upon a street or public road, on the same conditions as are by the present section imposed on the company in relation to such a body, *mutatis mutandis.*

Restrictions as to Telegraphs under Streets and Public Roads.

7. The company shall not place a telegraph under any street within the limits of the district over which the authority of the Metropolitan Board of Works extends, or of any city or municipal borough or town corporate, or of any town having a population of thirty thousand inhabitants or upwards (according to the latest census), except with the consent of the bodies having the control of the streets within such respective limits.

8. Where the company intends to place a telegraph under a street or public road, the depth, course, and position at and in which the same is to be placed shall be settled between the company and the following bodies:

The body having the control of the street or public road:

The body having the control of the sewerage or drainage thereunder:

But if such settlement is not come to with any such body, the following provisions shall take effect:—

The company may give to such body a notice specifying the depth, course, and position which the company desires.

If the body to whom such notice is given does not, within twenty-eight days after the giving of such notice, give to the company a counter-notice objecting to the proposal of the company, and specifying the depth, course, and position which such body desires, they shall be deemed to have agreed to the proposal of the company.

In the event of ultimate difference between the company and such body, the depth, course, and position shall be determined in England or Ireland by two justices, and in Scotland by two justices, or by the sheriff.

9. Every underground tube or pipe of the company shall be so marked as to distinguish it from tubes or pipes of every other company.

Restrictions as to aboveground Works affecting Streets and public Roads.

10. The company shall not place a telegraph over, along, or across a street or public road, or a post in or upon a street or public road, except with the consent of the body having the control of such street or public road; subject to this proviso, that where the company is desirous of placing a telegraph over a public road, either along the same for a less distance in the whole than one hundred yards, or across the same, and the body having the control of such public road does not consent to the company so doing, then, on the application of the company to the Board of Trade for leave to do so, and on notice to such body, the Board of Trade may make inquiry and examination, and hear and determine the matter of the difference between the company and such body, and may either disallow the application of the company, or may authorise the company, notwithstanding the want of the consent of such body, to proceed with their proposed works, with or without modification, and subject or not to any terms or conditions, as the Board of Trade thinks fit; and the determination of the Board of Trade shall be binding on the company and on such body.

Removal of Works affecting Streets and public Roads.

11. In the following cases—

If any part of the company's works affecting a street or public road is abandoned, or suffered to fall into decay.

If the company is dissolved, or ceases for six months to carry on business.

the body having the control of the street or public road affected (in the former case) by such part of the company's works as aforesaid, or (in the latter case) by any of the company's works, may give notice to the company, or leave a notice at the last known office or place of business of the company, to the effect that if such works (being works affecting a street or public road) as are specified in the notice are not removed within one month after the notice given or left, the same will be removed by the body having such control; and in every such case, unless such works are removed accordingly, the body having such control may, without prejudice to any remedy against the company, remove such works, or any part thereof, and sell the materials thereof or of any part thereof, and, out of the proceeds of such sale, reimburse themselves their expenses relative to such notice, removal, and sale, and consequent thereon (rendering the overplus, if any, to the company), and may recover any unpaid residue of such expenses from the company. The present section shall apply to an existing company, in respect of any work already constructed or to be hereafter constructed, as well as to a future company.

12. In case the body having the control of any street or public road shall at any time hereafter resolve to alter the line or level of any portion of such street or road under, over, along, or across which any work of the company may be placed, the company shall from time to time be bound, on receiving one month's notice of such intended alteration, and at their own expense, to remove such work, and to replace the same in such position and manner in all respects as shall be required by such body, or, in the event of difference between such body and the company, in such position and manner in all respects as shall be determined by the sheriff.

Restrictions as to the Opening of Streets and public Roads.

13. Subject to any special stipulations made with a company by the body having the control of a street or public road, and to any determinations, orders, or directions of the Board of Trade, justices, or sheriff as aforesaid, where the company proceeds to open or break up a street or public road, the following provisions shall take effect:—

The company shall give to the bodies between whom respectively and the company the depth, course, and position of a telegraph under such street or public road are hereinbefore required to be settled or determined, notice of their intention to open or break up such street or public road, specifying the time at which they will begin to do so, such notice to be given, in the case of an underground work, ten days; and in the case of an aboveground work three days, at least, before the commencement of the work; except in case of emergency, in which case notice of the work proposed shall be given as soon as may be after the commencement thereof.

The company shall not (save in case of emergency) open or break up any street or public road, except under the superintendence of the bodies

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to whom respectively notice is by the present section required to be given, unless such bodies respectively refuse or neglect to give such superintendence at the time specified in the notice for the commencement of the work, or discontinue the same during the work.

The company shall pay all reasonable expenses to which such bodies respectively may be put on account of such superintendence.

14. Subject to any such special stipulations as aforesaid, after the company has opened or broken up a street or public road they shall be under the following further obligations:—

They shall, with all convenient speed, complete the work on account of which they opened or broke up the same, and fill in the ground, and make good the surface, and generally restore the street or public road to as good a condition as that in which it was before being opened or broken up, and carry away all rubbish occasioned thereby.

They shall in the meantime cause the place where the street or public road is opened or broken up to be fenced and watched, and to be properly lighted at night:

They shall pay all reasonable expenses of keeping the street or public road in good repair for six months after the same is restored, so far as such expenses may be increased by such opening or breaking up:

If the company fails to comply in any respect with the provisions of the present section, they shall for every such offence (without prejudice to the right of any person to enforce specific performance of the requirements of this Act, or to any other remedy against them), be liable to a penalty not exceeding twenty pounds; and any such penalty shall (notwithstanding anything hereinbefore, or in any Act relating to Municipal Corporations, or to the Metropolitan Police Force, or in any other Act, contained) go and belong to the body having the control of the street or public road, and shall form part of the funds applicable by them to the maintenance of the street or public road.

15. That whenever the permanent surface or soil of any street shall be broken up or opened by the company, it shall be lawful for the body having the control of the street, in case they think it expedient so to do, to fill in the ground, and to make good the pavement or surface or soil so broken up or opened, and to carry away the rubbish occasioned thereby, instead of permitting such work to be done by the company; and the costs and expenses of filling in such ground, and of making good the pavement or soil so broken up or opened, shall be repaid on demand to the body having the control of the street by the company, and in default thereof shall be recovered by the body having the control of the street from the company in the manner hereinbefore mentioned.

16. The company shall not stop or impede traffic in any street or public road further than is necessary for the proper execution of their works. They shall not close against traffic more than one-third in width of any street or public road at one time; and in case two-thirds thereof are not wide enough to allow two carriages to pass each other, they shall not occupy with their works at one time more than fifty yards in length of the one-third thereof, except with the special consent of the body having the control of the street or public road.

(*To be continued.*)

TELEGRAPHIC LITERATURE.

We are enabled to add the following publication, relating to telegraphy, to the list of periodicals published in No. 71 of the Electrician:—

"Tijdschrift voor Telegrafie en aanverwante wetenschappen, onder redactie van R. K. van Eldik, T. W. Hagers en Z. van der Vegte. Amsterdam, H. J. van Kesteren."

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	1s. 11d.	per lb.
Second „	1s 5d. to 1s. 8d.	„
Third Negro	1s. 1d. to 1s. 2d.	„
Java	1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine none worth	2s. 8d. and above.	
Genuine mixed	1s. 9d. to 2s.	per lb.
Reboiled good	1s. 5d. to 1s. 8d.	„
Ordinary ditto	1s. 0d.	„

April 15, 1863.

Wm. Kirkmann,
4, *Howford Buildings, Fenchurch Street, E.C.*

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

INSULATION OF THE PERSIAN GULF CABLE.

To the Editor of The Electrician.

Sir,—To those readers conscious of the supreme importance of the subject of insulation for submarine cables, recent numbers of the Electrician must have been unusually interesting. Here we have the subject gone into by men who know practically something about it; one as an electrician of celebrity, the others as manufacturers of considerable standing and experience; and they clash and are at issue; but it is something more than the clashing of rival interests, which indeed should never obtrude itself in such discussions, but whatever the individual opinions may be of either one or the other, the audience must be benefitted, since it results in the elimination of important facts.

First we have the letter of Mr. Latimer Clark, who, as a member of the firm recently appointed telegraph engineers to the India Board, has doubtless deemed it incumbent upon him to show good grounds why, in spite of the adverse verdict of experience and experiment, the insulation of the Persian Gulf cable should be precisely similar to all hitherto existing cables, with perhaps one or two trifling exceptions. Well, he could do no less, since general dissatisfaction means a demand on the part of the public to be informed of the reasons why such and such a thing should have been done, which, according to the light they possess, would have been better left undone; and nothing less than a full explanation of the motives that influenced them in the choice of gutta percha was expected, either from Mr. Clark or some one else connected with the project, upon two or three accounts;—because the Government Committee ranked this material as at best but second class, and further disapproved of its use altogether in certain cases, of which this is unquestionably one;—because all subsequent experiments have uniformly confirmed the decision thus arrived at;—and because it was prevalently believed that the Council of India had determined on inaugurating a new era in submarine telegraphy, based upon conclusions sound, logical, and unavoidable, and which, up to this time, no one has attempted to disprove, simply because they are beyond refutation.

It is well when a man perceives that a certain position assumed, or course taken, requires defence; it is better still when he steps out boldly, states his reasons, and shows, or attempts to show, wherein he is justified; this Mr. Clark has done on behalf of all concerned in the projected Persian Gulf cable, not excepting himself; and he has apparently made out a good case. There is the undeniable fact that india rubber is a comparatively untried material, affording no tangible data whereon to ground trust and confidence in its efficiency. What do we know about it? The Government experiments were unquestionably in its favour, but the verdict could only apply to specially prepared specimens, submitted only to artificial tests, and that too for but a short time.

What would have been the result had these specimens been taken from cables which had been subjected for a series of years to all the ills of a working submarine cable? or, rather, how would india rubber insulation have stood practically, had we have had the same experimental proof of its adaptability, or otherwise, which a lengthened use would have afforded? The matter is wrapt in doubt, and that doubt can scarcely be construed in its favour. Further, there is the short length of india rubber cable submerged at Kurrachee: here is your boasted material put to the test, and with what result? A lamentable failure. If thus, in the first instance, it so notoriously failed, is not the sequence logical that we should distrust it, and by no means throw up a good insulator for one that has no antecedents, save this one, which is far worse than none at all? Such is the tendency of Mr. Clark's apparently unanswerable argumentation, and the most is made of it. But, even under these untoward circumstances, a believer in india rubber could hardly get out of temper with so good-natured an antagonist, who, while he lavishly patronizes one, pats the other encouragingly on the shoulder, and promises to be magnanimous to him some day—when he deserves it; for, strange as it may seem, Mr. Latimer Clark has great faith in the future of rubber, and prognosticates its pretty extensive use by and bye, notwithstanding he gives it a vital stab by instancing a case of its use, which, as he makes out, condemns it *in toto*.

The ball, having thus been set rolling, is forthwith caught up by Messrs. Wells and Hall, who, as became manipulators of the elastic gum for telegraph purposes, necessarily take a view directly opposite, and come out with a startling fact or two, which, probably, the world had only guessed at before. It is asserted, in contradiction to the foregoing, that india-rubber insulation had been partly adopted by the Government: a cable of this description, although but a short one, has been made by this firm for the Persian Gulf (by the way we should like to know something about it since it left North Woolwich), and, doubtless, had the Fates been propitious, that 20 miles would have lengthened into 1,000 miles ere this; nevertheless, take it as it is, it is a hard fact, though scarcely a new one. Although some may, from various motives, profess to ignore it, it is a fact for all that, and will,

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doubtless, turn out a very useful one, as it will furnish the information, proof, and data, which, Mr. Clark assumes, is wanting.

A new *regime* did not necessarily imply retrogression, or a return to a defective system that had been fairly tried and found wanting, in opposition to the rational course that had just received adoption; and Mr. Clark's respondents were prepared with samples to bid for the construction of the core of the projected cable, not perhaps with over much confidence as to the result; but here the startling fact comes to light that the gutta percha specimen was surpassed by every india rubber specimen sent, no matter who the manufacturer or what the mode of construction; and in the particular case of Wells and Hall, whose sample it appears surpassed all the others, the inferiority of the gutta percha sample is represented at the significant figure of some forty per cent., and these are the results of the testings for insulation made at the instigation of the India Council, by Messrs. Bright and Clark, their Engineers! To say that these results are extraordinary will scarcely convey an adequate idea of their importance, while it will require a much more elaborate and satisfactory defence than that submitted by Mr. Clark to justify so strange and perverse a departure from the teachings thereof. But in the end such conclusive and weighty testimony will bear down all opposition, and secure the universal adoption of caoutchouc insulation for all long lengths of submarine cables; unless, indeed, it can be shown that a high inductive capacity, like Paddy's holy coat, is an advantage rather than not, and that perfectness of insulation is by no means necessary, or even desirable. The advocates of rubber insulation may well rest contented with such results, and bide their time; nor do its opponents attempt to question its pre-eminent insulating qualities; they are perforce reduced to mere special pleading, and found their objections on alleged shortcomings which all experience proves does not exist. Seeing the upshot of this testing, it was rather a bold stroke to abjure the lesson it taught, and choose a gutta percha core after all; which, although made of the best unadulterated quality, betrays such inferiority. The irreconcileability of the two facts may well be dwelt upon, and the procedure of the projectors of the Persian Gulf cable excite the surprise and dissatisfaction of the public.

And here we cannot but ask—Why were these experiments instituted? not surely to ascertain which of the two materials were the better insulator, because that point had been definitely settled long since; and if, on the other hand, india rubber was to be deemed out of the question as a suitable insulating agent, by virtue of its tendency to go bad after submersion, as is alleged by Mr. L. Clark, and in proof of which he instances the Kurrachee cable, it is evident that judgment against it had been already pronounced by forgone conclusions; and we are left in a state of utter bewilderment as to the motives which could have actuated those gentlemen at whose instigation the experiments were made, and who further solicited samples to be sent in for that purpose constructed of a material which they never intended to adopt, whatever might be the result of such testing.

But Messrs. Wells and Hall not being the makers of the two thousand yards of Kurrachee cable, that terrible matter had yet to be grappled with, and as only "the manufacturers" were competent for the task, they accordingly step forward and confute the evidence of Mr. Latimer Clark. Aha! good my friend, this scurvy two thousand yards tells nothing for your argument after all. India rubber is not at fault; of that everybody was convinced all along; the defect was purely mechanical; and, if a doubt remain, the explanation rendered by "the Manufacturers" must dispel it. There is only one way of making good india rubber telegraph wires, and this is not by the application of longitudinal layers.

At the onset one might have thought Mr. Clark firmly intrenched in an impregnable position, but having been rebutted from two quarters, what is his position now? and has he really advanced anything that is worthy in the slightest degree of being considered a justification of the use of gutta percha in a cable which official oracles tell us is to surpass, by a pretty tolerable figure, all pre-existing cables?

There are some cases which do not admit of defence, and wherein the observance of a discreet silence does more to disarm adverse criticism than the best defence that can be penned; and this Persian Gulf cable case is one of them. Three things have been repeatedly demonstrated in the columns of this journal and elsewhere, two of which apply to caoutchouc only, the other, perhaps, to both materials in an equal degree, viz.: an adaptability to hot climates, superior insulating qualities, and a durability which knows no decay in any circumstances appertaining to submarine telegraphy—the last named quality gutta percha may lay claim to at temperatures below 70°, but not to the other two. But it is upon the last named that Mr. Clark casts a doubt, and upon this doubt he mainly founds his argument of defence for the insulation of the cable in question, supported as it appeared to be by the failure of the experimental section above alluded to. On the other hand, in support of the durability of gutta percha, he adduces the case of the Red Sea cable, represented to be intact after a lapse of years, and that too in a tropical locality. It is an unfortunate selection for Mr. Clark to make; the public feel sore at the mention of any good qualities existing in a cable for which they have to pay so handsome a sum annually, and for which they get no return. If the insulation of this cable is really as "perfect, both electrically and mechanically, as whon it left the manufactory," why does it still remain a huge and disgraceful piece of lumber? and why should the Company still have the shamefacedness to take a percentage upon their capital out of the national exchequer? Most people will be chary in accepting this unqualified testimony to the perfectness of the insulation of the Red Sea cable.

We have seen, however, that the case made so much of as proving the non-durability of caoutchouc breaks down entirely unless Mr. Clark can disprove the statements of "the Manufacturers." But this precious Red Sea cable is to be taken as a proof also that gutta percha may be used with impunity in hot climates, and perhaps it will be necessary to refresh the memory of the public with another Rangoon cable ere a more rational belief becomes prevalent; still the fact is indubitable, and will ever remain so, that at a moderate summer heat the insulator becomes plastic, and the conductor runs imminent risk of swerving from its centricity. What, therefore, can justify the use of it when you have a better insulator close at hand, upon which temperature has no effect. An old worn-out, worm-eaten, leaky vessel might possibly carry a cargo to New York, but it is a hundred chances to one that she would not; the man would be deemed little short of mad who made the venture, and the loss of crew and cargo would hardly excite commiseration if they willingly committed themselves to its keeping. The cases are analogous; it is therefore most surprising that so thorough a tactician as Mr. Clark, who invariably thinks twice at least before he commits his thoughts to words, should venture on a statement which facts, too notorious to mention, invalidate.

It must be conceded, therefore, that the defence set up for the use of gutta percha in the Persian Gulf cable is worse than no defence at all, since the only point that seemed to tell against india rubber is satisfactorily made out to prove the opposite. As to that other shadow of an argument (that india rubber is an untried material), assumed doubtless because of the extreme paucity of objections that could be raised; it is not worthy of being pressed into the service; everything is in the same position at some period; but experiment affords us confident and accurate data to work upon; if it were not so the world would have come to a standstill ages ago, and civilization would have been arrested in mid-career. But this even is not correct. India rubber is *not* an untried material, unless we are to conclude that it is "untried" because we cannot point to a cable of 500 or 1,000 miles. There is no material in existence which affords more abundant and conclusive evidence of its indestructibility than caoutchouc, nor one therefore which can lay such satisfactory claims as to its adaptability for the core of submarine telegraph cables.

It could be easily shown, if one only had the time, that not a few of Mr. Clark's own statements could be refuted by other statements which run counter thereto, and yet both shall have emanated from his own lips. And so of other electricians. There is not one of them who has not times without number, dwelt upon that great bugbear to rapid signalling through long submarine cables, viz., the retardation caused by inductive action and insisted upon the necessity of reducing it to as low a point as possible, and yet to a man they would make any miserable shift rather than have recourse to that material which alone can secure comparative immunity from the evil.

There are a few cases of this description in which the written and spoken words from the same man are so utterly at variance, and the use of an inferior commodity so persistently stuck to, as to afford ample materials for an article at some future time specially devoted to electrical tergiversations. M.

To the Editor of The Electrician.

Sir,—To me it is a matter of perfect indifference as to whether yourself or I succeeded in setting Mr. Laming right. I do not, therefore, desire to arrogate to myself even the shadow of any merit thereby accruing; but I hasten to answer his last question as to my being serious "when I say in effect that a hollow straw will discharge as much water in a given time as a sewer, making up in velocity what it wants in capacity." This, as put by Mr. Laming, is of course an absurdity, but allow me to remind your correspondent, that the data upon which my reasonings are based form the origin of my having entered the arena opposed to him, and that for which throughout I have contended, and which, to produce equal results, he at length has acknowleged to be necessary, is, that an "adequate source" of

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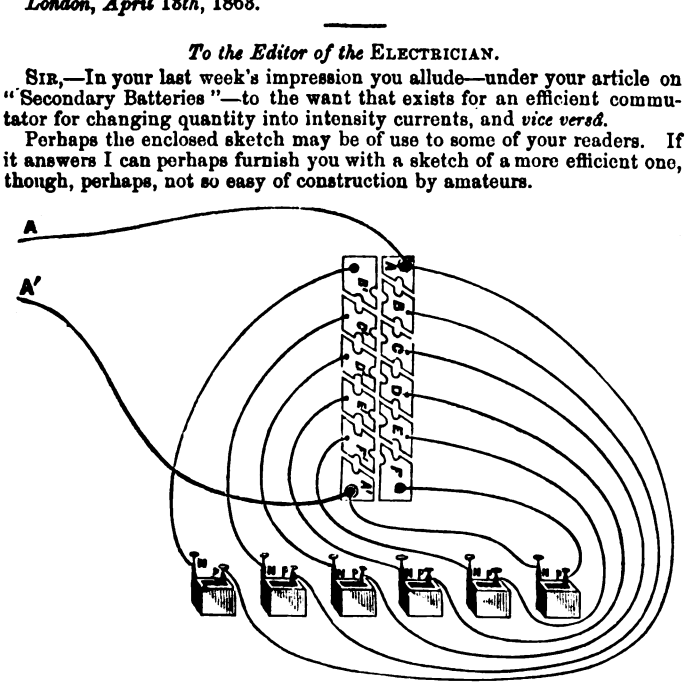
power, either electrical or hydraulical, must be applied; add this to Mr. Laming's "Straw *versus* Sewer," and I shall feel obliged if he will kindly inform me what physical law I outrage by positively asserting that the straw would transmit the same quantity of water as the sewer would in equal times.—I am, sir, yours respecfully RELAY MAGNET.

London, April 18th, 1863.

To the Editor of the ELECTRICIAN.

SIR,—In your last week's impression you allude—under your article on "Secondary Batteries"—to the want that exists for an efficient commutator for changing quantity into intensity currents, and *vice versâ*.

Perhaps the enclosed sketch may be of use to some of your readers. If it answers I can perhaps furnish you with a sketch of a more efficient one, though, perhaps, not so easy of construction by amateurs.



The above represents a commutator (with batteries attached) for changing current from quantity to intensity, and *vice versâ*.

It consists of metallic strips fastened to a piece of wood by means of a screw and nut, to which also wires from batteries are joined.

By connecting A B C D E F and B' C' D' E' F' A' together respectively, by means of small metallic pegs, the arrangement will be complete for "quantity."

If "intensity" effects are required B B', C C', D D', E E', F F' should be joined together by means of the metallic pegs.

The wires A and A' do not require shifting in either case, and the metallic pegs will make good contacts. E. F.

Exeter, April 6th, 1863.

Telegraphic News.

ATLANTIC TELEGRAPH.

WE have to correct an error which appeared in a paragraph under the above heading in our last week's impression. Instead of the amount subscribed in New York being £18,000, it should have been £38,000. From information received by the last mail we are enabled to state that this amount has been increased to £46,000.

PRESENTATION TO A TELEGRAPHIST AT MANCHESTER.—Mr. William Powell (Engineer to the United Kingdom Electric Telegraph Company), who is about to reside in London, was entertained at dinner, on Wednesday, 8th inst., at the Bull's Head Hotel, Manchester. Mr. John Doherty, Commercial Superintendent of the Company, occupied the chair most ably. The dinner was everything to be desired, and reflected great credit on Mr. Platt. After the disposal of the customary loyal toasts, Mr. Samuel Percy rose, and, in the name of a large number of subscribers, presented Mr. Powell with a gold watch and chain as a token of the high admiration and esteem with which he has for a long time been held by his friends, to which Mr. Powell made a most suitable and feeling reply. The watch and chain are of beautiful workmanship, and were supplied by Mr. Mentha, of Manchester. The watch contains the following inscription:—"Presented to William Powell, Esq., Engineer of the United Kingdom Telegraph Company, by a large circle of friends, as a token of sincere regard and esteem. March, 1863." After a very agreeable evening had been spent, the company dispersed at a late hour.

Miscellanea.

THE valuable properties of *charcoal* as a means of absorbing and destroying the organic impurities in air by being filtered through it, have lately been applied on an extended scale to the ventilation of sewers, by Dr. Letheby and Mr. Haywood. The whole of the sewers in a space of fifty-nine acres in a crowded portion of the east of London have been for eighteen months past connected with the outer air by means of charcoal ventilators. The success of this plan has been perfect. Not only has all stench ceased from the ventilating gratings, but actual observation has repeatedly proved that the odour of the sewer gases is not perceptible when they have traversed the charcoal, and a chemical examination of charcoal which has been in use during the whole of the period, shows that the organic *imasurata* is completely changed by its wonderful oxidizing powers into alkaline nitrates. Thus, by the agency of a little wood charcoal, the gaseous emanations of sewage, which the experiments of Dr. Barker, and the clinical observations of Dr. Murchison, have shown to be the cause of a form of continued fever, aptly termed *pythogenic*, are completely arrested on their passage up the ventilating shafts, and changed into perfectly innocuous compounds.

SEMAPHORES.—The *Revue Contemporaine* publishes an article by M. Felix Julien on the semaphores now established or in course of construction along the coasts of France. Their number is upwards of 150; each consists of a small white house roofed with red tiles and surmounted by a tower. From this there rises a vertical mast, 10 metres in height, provided with three moveable fan-shaped wings, by means of which signals are made to ships passing even at a distance of six miles. The ship replies by its flags, and thus news may be instantaneously transmitted from the vessel to any part of the country, thanks to the telegraphic wire with which each semaphore is now provided. The semaphore is essentially an instrument of attack or defence in times of war; but even during peace time it may perform valuable service if, as M. Julien justly suggests, its communications of the state of the weather be received at a central office, established at Paris, and thence made to radiate to all the points of the French coast—a plan perfectly in accordance with that now conducted in England by Admiral Fitzroy. The signals used by French vessels for great distances consist of the three primitive figures of geometry, viz., a square or ordinary flag; a triangle or flame; and a circle or ball. The combination of these three signals taken two by two, gives the first ten figures of our numeral system; which may be combined so as to express any number between 1 and 10,000. This is, indeed, the number of articles contained in the French code of signals for the mercantile navy. The semaphore replies to these signals by its three wings, each of which can assume six different positions. Each of these positions represents one of the first six numbers. The first wing represents the units, the second the tens, and the thirds the hundreds. But to render the system more simple, the semaphore first telegraphs the page of the signal-book, and then the line of the page separately.

THE TEMPERATURE OF INCANDESCENT BODIES.—M. Becquerel, of Paris, has published the results of some interesting researches upon the determination of high temperatures, by means of the intensity of the light emitted by the incandescent bodies. He employed a thermo-electric pyrometer, formed of platinum and palladium wires, united together without soldering, for the space of about 4-10ths of an inch. The intensity of the thermo-electric current developed in this pair is very great: it increases with the temperature in a regular manner, without the unequal variations observed when other metals are employed; this pair is also available to near the fusing point of palladium, 2,700 deg. Fah. By this instrument, M. Becquerel ascertained the fusing point of silver to be between 1,710 deg. and 1,730 deg., and that of gold scarcely 1,962 deg.

A PROPOSITION has been laid before the Admiralty, by a Mr. Walenn, a London chemist, to coat iron of any size, from a ship's bottom itself, as one whole, to a single bolt for the armour plate, with a deposit of metal, such as brass or any other alloy, as thin or as thick in substance as may be wished, with a bright, hard, enamelled surface. It will be at once seen that this would supply what is chiefly wanted—the means of preventing the oxidation of ships' armour and bolts, and the fouling of iron ships' bottoms. Mr. Walenn has been directed to send in to the Admiralty estimates of his proposed plan of electrotyping.

ARTIFICIAL MEERSCHAUM.—This substance, so highly prized by smokers for the bowls of pipes, has sometimes been imitated, or artificially produced, with more or less success. M. Bertoli immersed large spongy fragments of the carbonate of magnesia in a hot solution of silicate of potash (soluble glass), thus forming a silicate of magnesia, approximating in its character to the natural product. The fragments of silicate of magnesia were exposed to the air during several months, that the carbonate of potash, which is also formed, might deliquesce, and thus become removed from the mass. They were then sufficiently hard to be worked, and of a beautiful white colour. M. Wagner asserts that a very perfect imitation of meerschaum is obtained by incorporating with the curd of milk calcined magnesia, mixed with one-sixth part of oxide of zinc, and well drying the mixture.

To Correspondents.

J. COOK.—We have carefully read your description of the commutator, but we cannot perceive that it answers the required purpose, viz., of connecting all the positive, and also all the negative elements on the one hand, and the dissimilar metals of consecutive cells (avoiding all other contacts), on the other hand. Perhaps you may be able to make the matter clearer. The lower part of the figure is not explained.

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The Electrician.

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M. DU MONCEL ON THE POLARISATION OF EARTH PLATES.

(Continued from p. 275.)

In a second series of experiments, M. Du Moncel constructed a telegraphic circuit in which the gas and water conducts,—one of these in combination with a small plate of sheet iron as the opposite electrode,—or two plates of equal size, constituted the "earth plates." The results obtained under the various conditions are tabulated; and from the table it appears that, when the positive pole of the battery was connected to the earth plate of small surface, the negative pole being attached to one of the systems of iron tubing, a current of greater intensity (*i.e.* a circuit of less resistance) was obtained than when these conditions were reversed. From the fact of the larger electrode in this instance being, in all probability, highly oxidised, and therefore not only less liable to oxidation, but also under favourable conditions to act as a negative element, this result might with tolerable certainty have been anticipated, though other experiments appear to indicate that it may not have been wholly due to this cause. When the positive pole of the battery was attached to the *small* earth plate, the resistance of the circuit was measured, with the differential galvanometer, by 89·61 turns of the rheostat; in 20 days the resistance had increased to 101·94 of the same units. When, on the other hand, the positive pole was connected to the *water conducts*, this resistance was 111·13 in the first instance, and 103·86 at the end of nineteen days. These data will be sufficient for present consideration, since they were not negatived by any other result obtained in the course of these experiments.

The following conclusion, drawn by M. Du Moncel (p. 479) from the above-mentioned tables appears, therefore, simply inexplicable:—"The resistance of circuits is *greater* when the current of the line battery goes from the small to the large plate, than when it goes from the large to the small plate." A few pages further on, the author states that, "the resistance of a circuit is *less* when the current goes from the small to the large plate than when it goes from the large to the small one." There may be here simply a *lapsus pennæ*, in the first statement; but we can scarcely excuse the author for thus mystifying his readers.

But it is in the explanation of the effects observed that M. Du Moncel is peculiarly unfortunate. "All the effects that we have pointed out," he observes, "are principally due to the polarisation of the plates buried in the soil, this polarisation being the more detrimental as the surface of the *electro-positive* plate, upon which they (?) are always produced most energetically, is augmented. It will be understood, in fact, that, the larger this plate, the more numerous will be the bubbles of hydrogen deposited upon it, and consequently the more considerable will be the detrimental effects of polarisation." It may be difficult for the reader to believe that this can be a fair transcript of the statements of our author; but any doubt upon this point will be sufficiently removed by the context. The assertion that a positive electrode can under any circumstances become polarised by hydrogen (*i. e.* an electro-positive) is confidently put forward; but the most surprising fact is that the author does not perceive that this kind of polarisation, supposing it could take place, would be far from detrimental to the voltaic effect. It is scarcely necessary for us to state either that an electrode polarised by hydrogen becomes for the time being electro-positive in relation to the same substance in its normal condition, or that such polarisation is invariably effected, not at the anode, but at the cathode, in the electrolyte.

With somewhat amusing *naïveté*, however, the author states that he assured himself of the accuracy of his explanation by the following experiment, which, though interesting in itself, certainly does not, so far as we can perceive, contribute in any way to strengthen his position. A small plate of rolled iron was placed in the centre of a hollow cylinder of the same metal, contained in a wooden tub. The positive pole of one couple of Daniell being attached to the plate, and the negative pole to the cylinder, the deflection of the galvanometer placed in circuit was:—

At the moment of closing the circuit ...	34° 5′
In 10 minutes	35° 2′

When the connection of the poles with the electrodes was reversed, the deflection was:—

At the moment of closing the circuit ...	29° 15′
In 20 minutes	23° 24′

This, according to M. Du Moncel, should be sufficient proof that, in the second experiment, the polarisation *by hydrogen* of the larger surface in connection with the *positive* pole of the couple, was the cause of the decreased effect. But it is obvious that in this case the smaller electrode, connected with the negative pole, could alone become polarised by hydrogen, and that, viewing the electrodes as a secondary couple charged by the primary voltaic cell, this plate would constitute the positive element. It thus appears, contrary to the conclusion of the author, that the *smaller* the surface of the electrode exposed to the effect of polarisation by hydrogen, the greater will be the resistance of the circuit. This, moreover, is in complete accordance with the conclusions derived from the experiments to which we referred last week, as well as with the experiments, when rightly interpreted, of M. Du Moncel himself.

We need not follow the author further into this subject, except by giving the concluding paragraphs of his paper, which will show how completely the principal points involved in the essay have been misunderstood.

"There is now one point upon which I may insist for a few moments, because it appears to me not to have been, hitherto, well understood: this is the part taken in the phenomena above described by the polarisation of the plates. It has been, for example, objected that, in an electrolyte, the deposition upon the plates of bubbles of gas takes place at the negative, as well as at the positive, pole; and, with plates of unequal size, constitutes about the same obstacle to the passage of the current, whatever may be the direction of the latter in relation to these plates. No doubt, if the phenomenon of polarisation consisted in this simple obstacle to the passage of the current, this reasoning would be correct; but this phenomenon takes a much more important part, in consequence of the electrisation communicated to the bubbles of hydrogen by the fact of the decomposition of water. These bubbles, in fact, assuming the polarity of the fluid, tend to communicate to the plates upon which they are deposited the electricity which they possess, and, consequently, to originate upon them an electro-motive force, e, *which acts in the same direction as that of the battery on the negative plate, but which exerts its action in the contrary direction upon the positive plate*, and causes the electro-motive force of the pile to become $E-e$, instead of E.

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"Theoretically speaking, all these bubbles should be conveyed to the negative pole, to constitute the electro-motive force *E*. But, in fact, a portion of the bubbles escape the electrolyte recompositions, and *become deposited upon the electro-positive plate;* and it is these alone which constitute the effect of polarisation, properly speaking, and which give rise to the secondary current, commonly termed "current of polarisation." As these bubbles are deposited in greater quantity as the surface of the electro-positive plate is increased, it will be understood that the detrimental effects of polarisation become more energetic as the surface of the positive electrode, within the electrolyte, is augmented. It is for this reason that, in our formulæ, we have always taken the value $E-e$, which, moreover, perfectly explains the effects observed."

"HOLMES'S MAGNETO-ELECTRIC LIGHT AS APPLICABLE TO LIGHTHOUSES."

In a little volume before us, under this title, the author has contrived to condense within a few pages a large amount of valuable information upon a most interesting subject.

Commencing with the first application of the electric light to light-house purposes at South Foreland, in December, 1858, we have the result of the "observations made by a Royal Commission," in all respects favourable to electricity; but what is of much greater importance in a scientific point of view, Professor Faraday also made observations about the same time, and in his report (dated April 29, 1859) he states that—

"Professor Holmes had *practically* established the fitness and sufficiency of the magneto-electric light for light-house purposes so far as its nature and management were concerned; the light produced was powerful beyond any other that he had yet seen applied; and in principle might be accumulated to any degree, its regularity in the lantern was great, its management easy, and its care there might be confided to attentive keepers of the ordinary degree of intellect and knowledge."

"Again," says the author,

"He reported to the Trinity House, after a subsequent experiment of six months' duration, throughout the whole of which time the proprietors were precluded from any supervision.

"The light has proved to be practicable and manageable, and has supplied the means of putting into a lighthouse lantern for six months or more a source of illumination far surpassing in intensity and effect any other previously so employed; he did not know at what cost this result had been obtained, but, unless that was very great indeed, he was of opinion that a large increase upon the expense of the old method (estimated upon the quantity of light obtained) ought to be allowed in the first establishment of a mode of illumination which apparently promised many improvements during its further developments."

After briefly adverting to the discovery of the magneto-electric current by Faraday in 1831, the author traces the development of the "Lighthouse System" from the early use of "Beacon Fires," to the present powerful, but still cumbrous and imperfect, Argand lamps, giving an extremely lucid yet concise essay upon "the conditions necessary for the production of light by mechanical, chemical, and electrical agencies, showing why the latter is the most intense yet discovered, and hence, if capable of easy management and cheapness of production as compared with others, it fulfils all the conditions necessary for its adaptation to lighthouse purposes.

That the first desideratum is accomplished by Mr. Holmes's invention, we have first the testimony of Professor Faraday, and, secondly, the evidence of our own senses, since, during the time the International Exhibition was open last year, one of the machines was in operation daily for four and a half hours, during which time it maintained its full splendour, so far as the eye could judge, required apparently no attention on the part of the attendants, and "did not once go out," from any imperfection of the machinery or want of continuity in the current.

With regard to the secondary consideration, "expense," we are slightly at issue with the author, believing that he has over-estimated the probable cost of maintenance of the electric light.

The extreme estimates of expenditure, given in a note appended to the work, are:—

For lamp as at present used..	£500 per annum.
For electric lamp.....	700 do.

Considering that "with the magneto machine, as used at the South Foreland, one engineer and one labourer only were required in addition to the existing staff, but that while the old light was consuming *manufactured* oil and wicking, the engine would only consume coke, or, with properly constructed furnaces, raw coal, we apprehend that the difference in cost of material consumed alone would not only cover the increased labour employed, but leave a fair margin in favour of the electric apparatus.

Want of space precludes our entering into the interesting details given of the mode of construction and operation of the machinery employed, but we may do so at some future period; as it is a careful compilation of facts and figures bearing upon a subject of vast importance, for the question here raised is one, on the correct solution of which may depend not only the salvage of property to an enormous extent, but it is a matter upon which may hang the lives of thousands of Britain's bravest sons.

ON THE MECHANICAL THEORY OF LAYING SUBMARINE CABLES.

BY WILLIAM GRAVATT, ESQ., F.R.S., F.R.A.S.

[The following paper, reproduced from the *Philosophical Magazine* for July, 1858, is of considerable interest and importance in regard to the theory of laying cables; and successfully opposes some of the views on this subject which have been enunciated by Professor Airy, and which are now generally prevalent on the continent.]

I considered this subject, and, as is well known, arrived at my conclusions long ago; and notwithstanding the conclusions I see were come to at the last meeting of the British Association, and at other meetings, and notwithstanding the Astronomer Royal's two papers on the subject, I feel that my original conclusions are unshaken.

The subject is of great importance, and I will (if you will allow me) give you as brief an abstract of my ideas as I possibly can.

I have demonstrated (but without a diagram it is almost impossible to give the demonstration), that if a vessel be running in a straight course at any uniform speed whatever, and the cable is being paid out over the stern at the same velocity, then, in the case where the strain tending to break the cable as it leaves the stern is just equal to the weight in water of a portion of the same cable, whose length is the depth of the sea, the cable will be at any instant in the same condition as to tension and pressure as if it were simply lying straight on an inclined plane surface immersed in water; there will be no strain whatever on the particle which happens at any instant to be the bottom particle of the cable, and the cable will therefore sink down in a vertical plane with uniform velocity, and be laid (not stretched) straight along the bottom of the sea without any waste.

Let

α = the angle the cable forms with the horizon.
t = the terminal normal velocity in feet per second, or the velocity of the cable at right angles to its length.
V = the velocity of the ship in feet per second.
w = the weight in pounds of one foot of the cable, in water.
d = diameter of the cable in feet.
D = the depth of the sea in fathoms.
L = length in fathoms, from the stern of the ship to where it touches the bottom of the sea.

Now the resistance expressed in pounds to each foot in length of a rough cylinder moving sideways in sea water is $\cdot 8dv^2$ pretty nearly (d being the diameter in feet, and v the velocity in feet per second).

We must have therefore $w \cos \alpha - \cdot 8dt^2 = 0$, or $t = \sqrt{\frac{w \cos \alpha}{\cdot 8d}}$.

We must also have $V = \frac{t}{\sin \alpha} = \frac{1}{\sin \alpha}\sqrt{\frac{w \cos \alpha}{\cdot 8d}}$, and also $L = D$ cosec α.

Now, taking as an example $w = \cdot 32$ and $d = \cdot 05$, as is pretty nearly the case in the present Atlantic cable, we get

$$\log t = \tfrac{1}{2}(\log 8 + \log \cos \alpha),$$
$$\log V = \tfrac{1}{2}(\log 8 + \log \cos \alpha) - \log \sin \alpha.$$

From whence, taking α = successively 10°, 20°, &c., we get immediately the following table, which we can easily extend:—

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Values of α.	Velocity of ship in feet per second.	Velocity of ship in knots per hour.	Values of L when D is taken unity.	Terminal normal velocity in feet per second, or values of t.	Tension in pounds on leaving the ship, the depth of the sea being D in fathoms, at 2 lbs. to the fathom.	Tension at the bottom.
10°	16·18	9·71	5·76	2·81	2D	0
20	8·02	4·81	2·92	2·74	2D	0
30	5·26	3·16	2·00	2·68	2D	0
40	3·85	2·31	1·56	2·48	2D	0
50	2·96	1·78	1·30	2·27	2D	0
60	2·31	1·39	1·15	2·00	2D	0

Note.—The slip is obviously V vers α in feet per second, giving a resistance (as will be afterwards shown) of $\cdot012\,(\cdot6V \text{ vers } \alpha)^{1\cdot9}$ pounds per fathom, or $\cdot012\,(\cdot6V \text{ vers } \alpha)^{1\cdot9}$ L pounds on the whole, which ought in strictness to be subtracted from the weight of D, but which is too small a quantity to be noticed in practice, at least in any cable similar to this.

Now, taking the greatest depth of the sea to which the cable in question is to be exposed at 2,000 fathoms, and each fathom to weigh in water $6 \times \cdot32 = 1\cdot92$ lb., say 2 lbs. per fathom, we have 4,000 lbs. for the strain on the cable, whatever may be the velocity of the ship; or as the cable is said to break with about 4¼ tons, or 9,500 lbs., the greatest necessary strain in smooth water is about four-tenths the breaking weight.

But if the cable be paid out at a greater velocity than the horizontal velocity of the ship, the cable will be (so to speak), slipping down the supposed inclined plane, and we must, in that case, find the resistance due to that slipping velocity.

Now this resistance is not exactly as the square of the velocity, nor is it indeed exactly as the diameter of the cable.

Upon the whole, I consider from a comparison of experiments, principally those of Colonel Beaufoy, that when the velocity in knots per hour is v, the resistance in pounds per fathom will, for the cable here supposed, be nearly enough represented by $\cdot012\,v^{1\cdot9}$.

For the sake of brevity I shall take only the example of this cable at an angle of 20°, where the velocity is, we see, 4·8 knots per hour. Now, taking the depth of the sea at 2,000 fathoms, we have $L = D \operatorname{cosec} \alpha = 2{,}000 \times 2\cdot92 = 5{,}840$ fathoms.

Taking, for example, the slipping velocity of the cable equal to the velocity of the ship, or paying out twice the necessary length of cable, we find for a slipping velocity of 4·8 knots per hour, a resistance of about ·2 lb. per fathom, or the total slipping resistance of the cable 1,168 lbs., by which amount the strain on the cable at the ship's stern will be reduced, or the greatest strain will be $4{,}000 - 1{,}168 = 2{,}832$ lbs., or to reduce the strain little more than one-fourth, we should at this velocity have to waste half the cable. Again, a waste of 1 knot of cable per hour, or a little more than 20 per cent. of the cable, would only reduce the strain about 70 lbs.

From the above, it appears that we are not able materially to reduce the strain upon the cable without occasioning excessive waste, unless at "Leviathan" speed.

Now if, on the other hand, we increased the tension of the cable beyond that due to the simple depth of the sea, the cable would form a curve concave to the horizon, and we might find the form of this curve when the strain was 2 D, 3 D, or any multiple whatever of D; but it would be such very bad engineering to *stretch* or *strain* a cable over the bottom of the sea, when we ought, on the other hand, really to allow waste (according to circumstances) to sink into its irregularities, that although I have considered this state of the cable, I think it practically necessary to observe only, that if from any accident the paying out of the cable is obliged to be discontinued, then, in order to avoid a catenarian strain that might be fatal, the motion of the ship should instantly be reversed, and if in very deep water she should run back until the cable hung vertically, or nearly so, a distance which is expressed by $D - L \text{ vers } \alpha$ or $D\left(1 - \frac{\text{vers } \alpha}{\sin \alpha}\right)$.

A cross current could only curve the free part of the cable sideways without adding to the strain, or occasioning waste, as we readily see if we recur to the idea of the cable lying upon the supposed inclined plane surface; for although we made it curve in any manner by pressing against it sideways, it would, as before, be prevented from slipping down by the weight of a portion of the same cable, whose length was the perpendicular height of the plane.

I may just remark, that if the ship moved with an accelerated velocity, the cable would form a curve with the convexity upwards, and on the other hand, if she moved with a retarded velocity, the cable would form a curve with the convexity downwards.

With a brake-apparatus properly contrived and worked by practised *seamen*, the sending and pitching of the vessel in moderate weather ought not materially to increase the strain on the cable. and the nearer the brake-apparatus can be made to approach in its *action* that of (that exquisitely delicate and simple apparatus) the fly-rod and winch when in the hand of a *fisherman*, the more perfect it will be.

Whilst for very great depths it is very proper to consider the means we have, or may find out, of forming efficient cables of small specific gravity, yet, on the other hand, we ought not to forget that in steel we have a material whose modulus of tension is 6,700 fathoms, whilst for iron wire the modulus is only 4,000 fathoms.

The subject is very interesting, and I could go on much further, but that I fear I have already trespassed too much on your valuable space.

INDO-AUSTRALIA OVERLAND AND SEA LINES.

At the ninety-ninth monthly meeting of the Philosophical Society, Adelaide, the following important paper was read by Charles Todd, Esq., Superintendent of Telegraphs, the chair being occupied by His Excellency Sir Dominick Daly, the Governor-in-Chief.

Mr. Todd, upon being called by His Excellency to read his paper, commenced by remarking that the present was an appropriate time to call attention to the subject of the paper to be read that evening. He then gave a brief outline of the history of ocean telegraphy. The various modes of securing insulation of the wire cable suggested or adopted were reviewed. The attempts, eventually successful, to connect England with France were described. The history of the subsequent extension of the telegraph through the Mediterranean was enlivened by some humorous descriptions of the failures that attended many attempts to carry out that important object. The lecturer next described the various routes selected for a telegraph to India. In speaking of the failure of the various lines, the lecturer said the electric efficiency of the cables was often damaged in their manufacture. Next came the great Atlantic telegraph, the hopes it excited, and the mortification that followed its failure. He mentioned the different projects under consideration for connecting Great Britain with America by the Orkney Islands and by the Hebrides, and proceeded to consider the various plans for extending the Indian telegraph to Australia. Some interesting information was given as to the leakage of electricity by the cables, and the facility with which the locality of a fault in the line could be ascertained. By reference to a map prepared for that lecture, Mr. Todd pointed out the importance to England of having a system of ocean telegraphs not liable to interruption by enemies, as lines connected with continental telegraphy would be in the event of war. He stated also that there could be little doubt that communication would be completed between London and Rangoon by the commencement of next year. He proceeded then to consider the latest project of Mr. Gisborne for an Australian telegraph, and produced a specimen of the proposed cable, which he said was the best he had ever seen; but on this, the special subject of the paper, we will give the lecturer's own words:—Mr. Gisborne's propositions may be briefly stated as—1. To lay a cable from East Java to Moreton Bay in the following sections:—Banjawangi to Copang, 590 knots; Copang to Port Essington, 525 do.; Port Essington to Cape York, 635 do.; Cape York to Cape Cleveland, 619 do.; Cape Cleveland to Moreton Bay, 655 do. Total, 3,024 do. The cable to be similar to that laid in Red Sea, but about one cwt. per mile heavier. 2. Such cable to be either the property of the Australian Governments—in which case he was prepared to enter into a contract to supply and lay it—or to belong to a company, to whom the Governments should give a guarantee of six per cent. on the capital required; but in the event of the net profits of the company exceeding ten per cent., such profits to go either to the reduction of the subsidy or the tariff to be reduced. The estimated cost was set down at £800,000. He engaged to form a company on these conditions, and to complete the work in two years. Generally speaking, I may say that Mr. Gisborne's plans were favourably received, especially by Victoria and New South Wales. The New South Wales Legislature voted an annual subsidy of £10,000, and Victoria £13,000; the latter being contingent on the Home Government contributing something. Subsequently the Victorian Government proposed that they should pay one-half of the whole subsidy, with Tasmania and South Australia as co-contributors, the other half to be made up by the Home Government, with New South Wales, Queensland, and New Zealand as co-contributors: the contributions to be apportioned according to the number

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of messages sent. In this colony it was thought desirable, before pledging ourselves to support an expensive submarine line, that the question of the practicability of carrying it overland to the northern coast, somewhere in the neighbourhood of Cambridge Gulf or Port Essington, should be first determined; and in a report I furnished this Government I showed that, if practicable, a land line from Adelaide to Cambridge Gulf, and thence by two sections of cable *viâ* Timor to Banjawangi, would cost something like £400,000 less than Mr. Gisborne required. It will, of course, be understood that I did not advocate taking a line through a vast tract of desert country, where it would be a matter of immense difficulty, if not impossible, to keep it in repair, but only on its being shown that a route could be found which would be available for occupation. Referring to the question of route in my report on Mr. Gisborne's project in July 18, 1859, I said—"I do think it probable that an overland route will ultimately be found practicable; and while I am writing, Mr. Stuart's return to Adelaide, after having crossed our northern boundary, and found available country still stretching to the north, confirms my opinion in this respect." Mr. Gisborne, having so far concluded his negociations, returned to England in 1860. We have seen that the Red Sea and India cables failed, that in the Mediterranean the attempts to connect Canada with Alexandria were unsuccessful, and that the Malta and Corfu lines had both failed. The Dutch cable to Java also became notorious for its frequent breaks, and is at the present time unworkable. These repeated and costly failures could of course have but one effect, that of discouraging capitalists in embarking in these enterprises; but the question of the extension of submarine telegraphs, however, was of far too great importance to England to be allowed to rest here. The Imperial Government instituted elaborate experiments as to the best form for cables, and the manufacture of one intended to be laid from Falmouth to Gibraltar was commenced at the cost of the Home Government, and a scientific Committee was appointed jointly by the Lords of the Committee of the Privy Council for Trade and the Atlantic Telegraph Company to inquire into the construction of submarine telegraph cables. It was unfortunate that the guarantee granted to the Red Sea Company was for 50 years certain, irrespective of the cable working; for it left no inducement to the Company to incur any large expenditure in endeavouring to restore the communication. However, in the latter part of 1861 the line passed into the hands of a new Company, called the Telegraph to India Company, the Home Government having offered to convert the guarantee to the old Company into a Government annuity of like amount, payable at the Bank of England, as in the case of other Government annuities, which offer, somewhat modified, was finally accepted. Immediate steps were taken to repair, and, if possible, restore, the cable in the Red Sea, 200 miles of new cable being sent out, but without success. It has now been decided, I believe, to lay a new cable. I am also informed that the long neglected Euphrates Valley and Persian Gulf line is at length being vigorously prosecuted. The Indian Government have ordered a submarine cable of the most inproved form for the Persian Gulf, and it will leave England next June or July, and is expected to be laid before the end of the year, and the land lines from Constantinople, *viâ* Bagdad and Bussora, will be completed soon after. Major P. Stewart, R.E., is in control, and Sir Charles Bright and Mr. Clark are the engineers and electricians. Mr. Clark tells me (under date October 27 last) that there are no difficulties in the Gulf, and nowhere a depth of more than 60 fathoms. There can be little doubt that telegraphic communication will be completely established between London and Calcutta by this time next year. The Dutch Government, after ineffectually attempting to repair the Singapore and Java cable, have at length granted to Mr. Gisborne and his co-promoters an annual subsidy of £8,500 for 30 years to lay a new cable. The Malta and Alexandria cable, originally intended to be laid between Falmouth and Gibraltar, in depths varying from 1,500 to 2,500 fathoms, was specially constructed for the Home Government. It was laid by the end of 1861, in three sections. The core consists of a strand of seven copper wires, with three coatings of gutta percha and Chatterton's compound, served with hemp saturated in tar, and covered with eighteen No. 11 iron wires, and No. 0 wires for shore ends. It was tested under a pressure of 600 lbs. to the square inch. It continues to work well. It is under these favourable circumstances, that we have now to consider the fresh proposals advanced by Mr. Gisborne and his co-promoters. Profiting by past experience, it is now proposed to lay a cable about three and a half times heavier than that originally suggested, or weighing 74 cwt. per mile, with shore ends of about 50 miles each, weighing 154 cwt. per mile. The conductor consists of seven copper wires in a strand, insulated with three coatings of gutta percha and three of Chatterton's compound, laid on alternately, forming a core weighing 384 lbs. per knot. The core is well served with prepared jute, well saturated with tar, outside which are ten best charcoal-iron wires, No. 6 gauge, or No. 1 for shore ends, covered with a hard bituminous coating to retard the corrosive action of the sea and hydraulic mortar, which would harden on passing into the water. To lay such a cable as that just described between Java and Moreton Bay would cost £1,100,000. The financial conditions are as follows:—The promoters ask for annual subsidy of £50,000 for thirty years, instead of twenty-one years; and that the net profits over 15 per cent., instead of 10 per cent., as formerly stipulated, shall go to the reduction of the subsidy. The reason alleged for this is the difficulty in inducing capitalists to embark in enterprises of this sort, where so much risk is incurred, unless the prospects of large profit can be held out. They offer, however, in return, to transmit all messages on the service of the Colonial and Home Governments free to the extent of the subsidy; or, should the latter not contribute, the tariff charge of their messages is to be placed to the credit of the Colonial Governments. The proposed subsidy is to be proportionably payable on the capital actually paid up and expended, and is not to exceed £5 per cent. on such capital. No payment to be made till the cable has been in working order for three consecutive months; and the payments are to be proportionable to the period the line is in efficient working order, unless interrupted by war; but a period of ninety days in each year is to be allowed for necessary repairs. If the line should be interrupted for eighteen consecutive months, unless by reason of war, then the contract to be void. On the foregoing conditions being granted, the Company will engage to lay a cable, such as I have just described, between Java and Moreton Bay, or to Broad Sound, within two years and a half from the contract being entered into, unless prevented by war or accidents of the seas. If the cable terminates at Broad Sound, a saving of 350 miles of cable will be effected, and the actual outlay will be £70,000 less. It is stipulated that the manufacture and laying of the cable shall be open to public tender, and the lowest tender accepted, the satisfactory nature of which competent electricians in England shall determine. It would, in my opinion, be necessary for the Colonial Governments to have their own electrician in England, whose approval should be required in any contract or acceptance of cable. Another clause provides that the tariff of charges for the transmission of messages over the line shall be submitted to and approved by the Colonial Governments; the charge on the first opening not to exceed 2s. 6d. for every 100 miles for a message of 20 words. It does not state whether this is intended to apply to the line all through, or only between Java and Australia. If a through charge, it would be most exorbitant, and even between Java and Australia higher than I should think desirable. When Mr. Gisborne was in Melbourne he suggested a minimum charge of 30s. on this section; that I think would be reasonable, and I should consider a through charge of £7 would pay the Company better than a higher rate. The charge for a message of 20 words from Jubal in the Red Sea to London is £3 5s.; from Alexandria £2 6s. 9d.; and from Malta to Alexandria, £1 10s. The Indian tariff between Kurrachee and Rangoon, a distance of 2,700 miles, is 6s. The Red Sea and Mediterranean charges are at present high, but may be regarded as more local than through rates. The increase of business which the extension to India, China, and Australia would bring would, no doubt, enable the several companies to very considerably reduce their tariffs. The foregoing is an outline of the scheme put forth by the promoters. I may mention, *en passant*, that they also contemplate carrying a line to Canton, *viâ* Sarawak, Labuan, and Manilla—a distance of 2,080 miles; or *viâ* the French settlement at Saigon, a distance of 1,678 miles. With regard to the Australian line, they show that the cable would rest on a soft, muddy bottom, in depth seldom exceeding 50 fathoms. If that is the case, there can be no doubt of the project being carried out successfully; whilst the sections into which the cable is be divided would allow of 10 words per minute being transmitted, or say 240 messages of 20 words in 12 hours, giving 3 minutes for each message. The core of the Singapore and Java cable it is proposed shall be larger, so as to enable a greater working speed being attained. With regard to the coral reefs, Mr. Gisborne states, on the authority of the Admiralty charts, that it would be an easy matter to avoid them, and lay the cable on a sandy bottom throughout. As coral does not grow on an ordinary sandy bottom, but only attaches itself to rocks, the cable would be quite safe, even if laid within a short distance of the reef; but if it was necessary to cross the reef at any place, it would most certainly be speedily worn through and destroyed. A preliminary careful survey of the route to be traversed would therefore be absolutely necessary. The form of cable proposed I have already spoken favourably of; it only remains for me to add that the estimated cost is not excessive. The Malta and Alexandria cable,

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1,300 knots long, cost the Imperial Government £500,000. The length of the Java-Brisbane line is 3,024 knots; or, giving 151 knots for slack, and 317 knots surplus for repairs, in all 3,492 knots, set down at £1,100,000. But is it necessary to adopt this expensive scheme in order to establish telegraphic communication between Australia and Java? Cannot we advance our land lines to some point on the northern coast? If we can, I am prepared to show that it will not cost a moiety of the sum required by the promoters. I am firmly convinced, not only of the practicability of carrying the line overland, but that it would be quite as efficient and as free from interruptions as would be the submarine coast line. In no former period perhaps has Australian exploration been so vigorously and so successfully prosecuted as during the last few years; and the comparative ease with which Stuart and other gallant explorers have severally crossed the interior, and especially the glorious success achieved by Mr. Stuart in his last arduous journey, which more immediately affects the interests of the colony, justifies my urging, with all the earnestness the magnitude and importance of the work demands, that South Australia should be prepared to extend her telegraph to the northern coasts of this continent. I may mention that in a letter to myself, Mr. Gisborne says the promoters, though not personally favourable to a line through the interior, because of the difficulties they conceive would be experienced in maintaining its integrity, are nevertheless quite willing to give up their own plan and meet us at any point to which the Australian system may be brought; and if we will carry our line to Cambridge Gulf by the end of 1864, or thereabouts, the company will engage to meet us there. The costs of a land line would of course very greatly depend on the nature of the country to be traversed, whether a good supply of suitable timber within easy distances could be procured, and the extent of cartage of the materials, &c., and upon the method employed in carrying out the work, for I need scarcely remind you that it would be very easy to sacrifice large sums by mismanagement. Remembering that our object is to connect with Java, we have a choice of four routes for a land line. 1st. From Brisbane to Port Curtis, to which the Queensland Government will probably extend their communication for local requirements. Thence, following up the Burdekin, which runs nearly as far as 18° south, and within 120 miles of the eastern coast to the south of Carpentaria and Port Essington. 2nd. From Adelaide *viâ* Cooper's Creek and Burke's track to Carpentaria, and then branching westward to Port Essington. 3rd. From Adelaide by Stuart's track to the neighbourhood of Cambridge Gulf, or to the point where Mr. Stuart struck the coast in his last journey, near the mouth of the Adelaide River. 4. From Adelaide round the coast to King George's Sound and Western Australia to the neighbourhood of Exmouth Bay. In either of the first three routes the submarine cable would go *viâ* Timor to East Java, Cape Sedano; in the fourth it would have to be in one section of about 1,100 knots, which would be a disadvantage. The third, from Adelaide through Stuart Land, is the most direct. In 1859 I presented His Excellency Sir R. G. MacDonnell with an estimate of the cost of this route, in which I gave the cost of the land section at £177,600, or 1,480 miles (from Port Augusta) at £120 a mile. A more detailed estimate, made at the commencement of last year, gave £165,300. In this estimate I have allowed a large margin for poles, should the country be to a great extent sparsely timbered: but if, as I have reason to believe, it is on the whole well timbered, a large saving can be effected. I dare say £100 a mile will be nearer the mark; but, adhering to my original estimate, the cost of the third route would be:—Land Section—Port Augusta to North Coast, say 1,480 miles, at £120, including cost of stations, £177,600. Submarine—North Coast to Copang, say 450 knots; Copang to Cape Sedano, say 590 knots—total 1,040 knots, at £240 per knot, £249,600. Total, £427,200. The first route, from Queensland, would cost:—Land section—say 1,900 miles, £190,000; submarine—Port Essington to Copang, 525 knots; Copang to Cape Sedano, 590 knots; total, 1115, knots, at £240, £267,000—total, £457,600. The fourth, *viâ* King George's Sound, I estimate at about £450,000. So that the cost of the several routes does not vary much. Cartage of materials would, of course, be a very heavy item; but I am disposed to think that camels might be employed with advantage. Mr. Thomas Elder informs me that he could land camels at Port Augusta at £50 a head. Each camel could carry say 400 lbs. of material, besides food or sundries for the party. With a view to lessening the weight of material employed, it has been suggested by Mr. Towler that we might use a light threefold copper rope, weighing about two hundred weight to the mile, instead of the ordinary No. 6 galvanized iron wire, weighing six hundred pounds to the mile. Copper being a better conductor than iron would allow of the reduction in sectional area without increasing the resistance. And another advantage gained by the use of the lighter wire would be the lessened strain on the poles. But before deciding on the copper conductor, I should try on a short line as an experiment. I should be very careful about my insulation, and would probably use an insulator of this form (showing pattern), recently devised by me, but lighter than this. Should the light copper conductor be decided upon, one camel would carry about 1½ mile of wire and insulators; and, employing 300 camels, about 450 miles, or say 400 miles, of wire and insulators could be sent in one trip. The first cost of the camels would be about £15,000; but, if taken care of and not overburdened, they would probably realize 50 per cent. of their original value on the completion of work. The line should be erected in a very substantial manner; but for obvious reasons I should, where good strong poles could be got, not use more than about twenty to the mile instead of thirty. It would be necessary for the protection of the line to have stations every 100 or 150 miles, selecting of course good country for their location. Beyond the settled districts, these would have to be securely built, without external woodwork capable of being burned by hostile natives, and the men well supplied with the means of defence. In these positions I should have a staff of five persons; but in the occupied country I should have the building near a settler's station, and I should endeavour to arrange with the settlers along the line to afford assistance in keeping it in repair. As the whole of the country will undoubtedly be soon taken up, we should, by this means, be able to organize an effective and economical means of keeping the line in good working order. Three important questions in connection with this work have yet to be discussed—the annual cost of maintenance, the probable revenue, by whom and on what terms is the land section to be carried out and worked. I must refer to each very briefly. 1st. Annual cost of maintenance. Mr. Gisborne estimates the annual cost of his scheme as follows:—Six stations, including general superintendence, £18,000; annual cost of steamers and stores, £15,000; direction and home expenses, with engineer, £5,500; renewal fund, £12,000; total, £50,500. I set down the cost of the overland line from Adelaide, with 12 stations, at—Land section—12 stations, salaries and maintenance, £12,000; contingent expenditure, £5,000; renewal fund, £3,000—total land section, £20,000. Submarine—north coast to Java—stations, &c., £5,000; renewal fund, £3,000—total submarine, £8,000. Total annual cost of line from Adelaide to the north coast, and thence *viâ* Timor to Cape Sedano, Eastern Java, £28,000. If the submarine portion belonged to the Company working the Singapore and Java and the China cables, one steamer would be sufficient for effecting repairs. In estimating the annual cost, we have, in order to properly compare the two schemes, to take into account the difference in the outlay required in the construction. Taking the cost of one at £420,000 and the other at £1,100,000, the interest at 5 per cent. will be £21,000, as compared with £55,000, or £50,000, the subsidy actually asked for by the promoters of ocean scheme; and the annual contributions of the different colonies would be somewhat as under, according to which line was adopted:—Annual contribution—Victoria, £9,450, as compared with £22,500; New South Wales, £6,300, as compared with £15,000; South Australia, £2,100, as compared with £5,000; Tasmania, £1,050, as compared with £2,500; Queensland, £1,050, as compared with £2,500; New Zealand, £1,050, as compared with £2,500. 2nd. The revenue likely to be derived.—The promoters in their prospectus state that from official returns the number of vessels in the Australian trade is 2,400, representing a trade of £40,000,000. In 1860, Mr. Gisborne compiled from official records the number of vessels inwards and outwards in the Australian trade, excluding those engaged in the intercolonial trade, the South Sea Islands, and South America. He makes it as follows:—Victoria, 1,001 vessels; New South Wales, 524 do.; South Australia, Tasmania, New Zealand, and Queensland, 500 do.:—total, 2,025 vessels. The number of exporting and importing firms he sets down as follows:—Victoria, 150; New South Wales, 150; South Australia, Tasmania, New Zealand, and Queensland, 50:—total, 350. He assumes each vessel to occasion four messages (two each way), and each firm to send two messages a week (one each way); in all, 36,400 commercial messages. In their last prospectus the number is estimated at 40,000. Suppose we say 30,000 messages, and the charge 30s. for 20 words to Java; that would produce £45,000, barely paying the expenses of Mr. Gisborne's plan, and leaving a profit of £15,000 or £17,000 by the plan I have proposed. By whom shall the different portions of the line be erected and worked? I do not think an English company would undertake the land line. Their ideas of the bush are different to ours. Distance acts as a convex lens, and magnifies the difficulties. Mr. Gisborne talks of the police arrangements, &c. Well, I propose that South Australia should carry out the line to the north coast; either the Government by means of a loan, limited in the first

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instance to £120,000, or a local company with a guarantee. If the South Australian Government erected the line, the other colonies and the Imperial Government should be asked to guarantee a subsidy to supplement the net profits up to 6 per cent. If a company, a subsidy equal to 6 per cent. on the actual outlay, and all profits over 10 per cent. to go to the reduction of the subsidy. For the submarine cable I would invite Mr. Gisborne's company to meet us with a cable approved by electricians appointed by the Government, on terms corresponding with those proposed by the Company in their prospectus.

The lecturer, on resuming his seat, was warmly applauded.

The Chief Secretary said it was desirable to ascertain the possibility of finding suitable timber on the proposed route, and Mr. Waterhouse, who had passed over the country, would probably be kind enough to inform the meeting upon that point.

Mr. F. G. Waterhouse was sorry to say that there was very little suitable timber in that country. The flora consisted principally of spinifex and mulga; but probably they would not require poles so high as in places where vehicles would have to pass under the line.

His Excellency—Not so high; but they must be sufficiently substantial to carry the wire.

Mr. Todd—If there are large gum-trees we could saw the poles.

Mr. Waterhouse—The only timber is upon this side of the MacDonnell Range, but it is very large; beyond that there is very little timber.

Mr. Todd—It might not be always necessary to use timber. Stone piers might in some places be more economical than poles.

Mr. Waterhouse—Poles could not be erected on the MacDonnell Range. It is a hard granite rock; gneiss, in fact. There is already a telegraph to Moreton Bay and Queensland, and the interior can never be a line profitable for commercial purposes, there is such a scarcity of water and timber. There is a peculiar gum found on Stuart's Plains; but it is not very plentiful, and it is very distorted. It would be difficult to get a straight piece three feet long. In Arnheim's Land there is timber which would answer well, but it grows in a forest.

Mr. Todd—There can be no doubt the line I propose is problematical while the other is undoubtedly a practicable route. I was in the hope of gaining information from you, which I could not collect from Mr. Stuart's journal, as to the practicability of the suggested line.

Mr. Waterhouse—From the MacDonnell range to Newcastle water the soil is a micaceous dust covered with spinifex grass, which, as Dr. Wyatt knows, will live and grow for three years without rain.

Dr. Wyatt—Yes; the slightest absorption of moisture from the atmosphere will sustain it.

Mr. Waterhouse—Timber would have to be supplied on 300 miles of country where the cartage would be most difficult. It is intersected by creeks which take their rise in the MacDonnell Range and empty themselves into Lake Eyre, and this lake is silting up from the effect of floods.

Mr. Todd—It would make a great difference to this colony whether the line ran through it across the continent or by Moreton Bay. We should have to pay something extra for every message sent through the existing colonial line. It strikes me also that if South Australia were to carry out a line to the northern coast it would give her an additional claim for at least a temporary extension of her territory in the care of the new country.

Mr. Waterhouse—A part of that will scarcely be found habitable for Europeans—even the natives are migratory. We followed them up the river and found that they lived upon mussels.. As the river dried they found the waterholes. They were in advance of our party, and upon our return we found that the water had almost disappeared. We found the tracks of Mr. Stuart's former party, and no sign that rain had fallen in the interval; in fact there was evidence that there had been no rain for at least eighteen months. The centre of that country is the MacDonnell range. At Central Mount Stuart the country is sandstone and a line might be carried over it on stone piers.

Mr. Francis—Would not the copper or iron wire be valuable to the natives, and too great a temptation for them to resist appropriating it?

Mr. Todd—That objection was raised when I made my first estimate for the line to Melbourne. It was said that the blacks along the Coorong would be continually meddling with, it but they have never touched it.

Mr. Waterhouse—But they are natives who know something of us.

Mr. Todd—In this case also they would soon know something of us. When I laid the cable at Lake Alexandrina I gave a black fellow an electric shock, and ever since they avoid the wires most religiously. (A laugh.)

Mr. Waterhouse—Where they think they are safe they are prone to be very mischievous.

Mr. Todd—If a black fellow standing with his naked feet on moist earth were to touch the wire, he would get a sensible shock. (In answer to another question). Along the Coorong large birds, such as turkeys, are often killed by flying against the wires; not, of course, from any electric shock, but from the blow. But the best protection of the line against the natives would be by working on their superstitions.

The Chief Secretary said he rose to move a vote of thanks to Mr. Todd, and would avail himself of the occasion to make some remarks. He thought they would generally agree with the lecturer, whatever difference of opinion there might be as to which was the best route, that of the points where the telegraph might touch Australia, Cambridge Gulf was probably the best. He was of opinion also that circumstances would soon render that a feasible scheme; for he had no hesitation in saying that a twelvemonth would not pass over their heads before a settlement, however humble, would be made at that part of the coast. When once a settlement was placed there, a great difficulty would be removed. The question then arose which was the best route for laying the wire across the continent. The practicability of Stuart's route was the great question to be decided. If stock could travel to the Victoria or the Adelaide Rivers, there would be little difficulty in laying the wires on that route, which was decidedly the best they could have as regarded South Australia. It was, however, to be ascertained whether the state of the water was such as to enable stock to travel; if so, they need fear no trouble from the natives. The passage of stock and stockmen would have a subduing effect which would prevent depredations upon the property of the whites. If, moreover, it should be found that Stuart's route wes not practicable for stock, South Australia would not be benefited to such an extent by telegraphic communication across the continent. Still there were other routes, as Mr. Todd had pointed out, which would be available. He thought Mr. Todd had over-estimated the cost of the telegraphic communication with Queensland. That colony must, in regard to its own interests, have a telegraph, as the country was now, or soon would be, occupied to within two hundred miles of the Gulf of Carpentaria. Efforts were being made, also, to settle the Plains of Promise from the Gulf, and also to place settlements at the Victoria. He did not like prophesying, but thought he might venture to say that five years would not elapse until there were a series of settlements upon the Victoria River by way of the Plains of Promiso or Queensland. The whole would be comprised within what they in Australia considered the settled districts. There would be squatting stations upon the whole route, and there would be no difficulty whatever as regarded the maintenance of a line of telegraphic stations, save a few exceptional places. There was no want of timber, and there would be no difficulty in completing the line; while the cost would be reduced by the fact that Queensland would in its own interest extend the telegraph to the Gulf of Carpentaria, and reduce by one-half the cost of communication between South Australia and the Victoria River. There was one point upon which he would wish to have some information. Mr. Todd had been kind enough to show a specimen of the wire proposed to be laid down between Java and Australia. It was covered with a species of cement, and as it struck him that the strength of a line in its entirety was no greater than the strength at its weakest part, a crack in the cement would cause a corrosion in the wire, and so be fatal to it. Broken in one place, the rest would be useless; and he wished to know whether it was practicable to lay down a line of considerable length, so as to preserve that coating throughout the entire length.

Mr. Todd said he had estimated the cost from Adelaide £120 a mile, and by Queensland at £100 a mile. He had in each case allowed a large margin for the cost of poles in country sparsely timbered. Although Queensland might extend its line for local requirements to the vicinity of the Gulf of Carpentaria, they would require a toll for the use of that line. He would recommend also that such an important line should be erected in a more substantial manner than would be required for merely local purposes. He felt discouraged by the account given by Mr. Waterhouse as to the supply of timber on what he confessed would be his favourite route if practicable. As to the cable when laid upon a soft sandy bottom in still water the oxide of the iron which formed was not generally carried away. Upon a shelly bottom the oxide formed with comminuted shells a concrete, and was continually enlarging; but it did not follow that the cable should go if the cement were cracked. The wire coating was to protect the gutta percha from friction on a rocky bottom, and that would always be a weak point in cables.

The Chief Secretary said he probably ought to know something of the composition of Chatterton's cement, but he did not, and would be glad of any information concerning it.

Mr. Todd said the composition was kept a secret, but he believed

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that gutta percha and gum shellac formed its principal ingredients. It had been tested in water—in fact, all cables were now tested in pressure tanks.

Dr. Gosse seconded the motion.

His Excellency said he had derived great pleasure from the elaborate lecture delivered by Mr. Todd—a pleasure in which he believed every person present participated. It would have been impossible to have heard such details without feeling great interest, applying as they did to a line of proposed telegraph which he hoped to see before long a realized fact, notwithstanding the somewhat discouraging statements of Mr. Waterhouse. He thought the meeting would agree with him that if the settlements upon the opposite coast spoken of by the Chief Secretary were effected within twelve months, his hopes were not altogether without foundation. (Hear, hear.) It was a great matter, he considered, for the colony to have, when thinking seriously of such an undertaking, the advice and assistance of a person so competent to give both as Mr. Todd. He then put the motion, which was carried by acclamation.

That concluded the business of the meeting.

Parliamentary Intelligence.

HOUSE OF COMMONS.—April 17, 1863.

The Electric Light and Lighthouses.

Lord Lovaine rose to move for copies of the reports to the Trinity House of the South Foreland, Varne, and Dungeness light keepers; and of all reports from Professor Faraday subsequent to that of the 5th day of July, 1862, upon the electric light now in operation at Dungeness; and to ask the President of the Board of Trade whether it was the intention of the Trinity House to include the use of the electric light in the alterations contemplated at Portland. The noble lord, who was very indistinctly heard, was understood to urge the importance of this subject as one involving the lives of thousands, and the safety of an immense amount of property. The danger of mistaking the lights from ships, intended to be fixed beacons, in shallow waters, for the lights from the ordinary lighthouses on shore was very great, and had frequently led to most lamentable results. The electric light was an invention which had been for some time tried with the utmost success. It was a light which could not by possibility be mistaken for any other light, and it could be seen at an infinitely greater distance than the ordinary light. The noble lord then proceeded to read extracts from the reports of several commanders of mail and other packets in the habit of crossing the channel several times each week, in support of the superior advantages of the electric light. Amongst the authorities quoted was Captain Smithett, of the *Prince Frederick William*, who said he thought it would be a great boon to the seafaring part of the community if the electric light were generally adopted in all lighthouses. Professor Faraday likewise bore testimony to the immense advantages of the electric light as a guide to travellers over the ordinary oil or other lights. He was surprised to hear that the Board of Trade had given its sanction to the expenditure of £10,000 by the Trinity House for the alteration of the old oil lights at Portland. Now he could not think that any trifling or partial saving would be allowed to interfere with the adoption of such an important improvement as the one in question. If the expense of the construction of the electric light were even far greater than it really was, he was of opinion that considering the enormous interests at stake the Government ought not to hesitate about adopting it. The cost of it, however, was comparatively slight, and it would not occasion one shilling additional burden upon the people. He had been informed by the inventor that the Dutch government had adopted the light to a considerable extent. The electric light was in fact in the possession of the Trinity Board for a period of four years and a half, and he understood it had been used at intervals for two years and a half with perfect success. Frugality might be a virtue and caution also, but the former, as in this case of the electric light, might become parsimony, and caution cowardice. He might mention a simple little anecdote as illustrative of what seafaring men thought of this light. The inventor of the electric light was showing it at the Exhibition last year. One day whilst he was standing talking to the secretary of the Trinity House, a rough looking seaman came up to him, and having used certain expletives which he would not then repeat, said, "Why the —— did you take this light down from the South Foreland?" The inventor said, "Here is the secretary of the Trinity House, who commanded it to be taken down." The seaman then remarked "The Trinity House are a pack of fools. What do they know about what is wanting as a good light. It is we who sail upon the sea who really know what is wanting." It was this invention that was much required for the maritime service. The noble lord concluded by moving for the reports referred to, and asking the question of which he had given notice.

Colonel Clifford seconded the motion, and said he was happy to find it was not necessary to make any attack upon the surplus of the Chancellor of the Exchequer, or to ask for any public money to effect the important improvement so highly recommended by the best authorities on the subject. The cost attendant upon the adoption of the electric light would be very slight, and could be defrayed altogether out of the ample funds in the possession of the Trinity House. The Dutch, whom they were not accustomed to look upon as a very quick nation, had already adopted this invention in two or three most important lighthouses. Spain, too, which was not considered a very precipitate country, had also adopted it in their lighthouses at Ceuta, and other places on the coast, with the utmost advantage.

Mr. M. Gibson said, though the noble lord was not competent to move his amendment, he (Mr Gibson) had no hesitation in assuring him of his readiness to lay upon the table the most recent reports of Professor Faraday, to the Trinity House, on the subject, as well as the other reports referred to. With regard to the question of the noble lord, he (Mr. M. Gibson) had to inform him that the Trinity House had some time since suggested the desirability of making improvements in the lighthouses at Portland and other places. He did not think that sufficient time had elapsed for testing the electric light. It had been in use at Dungeness for about nine months, and there could be no doubt that it possessed many great advantages, one of which was, that it could be readily distinguished from all other lights; but it was absolutely necessary that they should have a light in lighthouses that could always be depended upon. They must have lights that would not go out, and it was in regard to that the electric light especially required to be tested. The one at Dungeness had occasionally gone out only for a moment or two, arising from the want of attention of the person having the care of it. It was a light that required constant attention, and it depended upon machinery; there was a steam engine for generating the electric fluid, and there was the machinery for connecting it with the lanterns. The only reason of the delay in generally adopting it was, that it should be thoroughly tested. Then came the question of expense. It might be quite right to adopt in certain places a more expensive light than that at present in use, but it was not necessary in all places. The cost of the lights was borne by the merchant shipping, as the lighthouses were supported out of the mercantile marine fund. The Trinity corporation were fully disposed to give the electric light every fair trial.

Mr. Bentinck said he was compelled, from circumstances, to differ from the opinion, with regard to the Trinity Board. He knew that a fair trial of the electric light had been impeded by the action of the Trinity Board. He would be prepared at a future time to show that the money which the Trinity Board annually wasted would pay ten times over the construction of the electric light in every lighthouse in England.

The subject then dropped.

TELEGRAPH BILL.

(*As Amended in Committee on re-commitment, and on second re-commitment.*)

To Regulate the Exercise of Powers under Special Acts for the Construction and Maintenance of Telegraphs.

Prepared and brought before Parliament by Mr. Milner Gibson and Mr. Hutt.

(Continued from p. 284.)

Restrictions as to Works affecting private or Crown Property.

17. The company shall not place any work under, in, upon, over, along, or across any land or building belonging to or enjoyed by the Queen's most Excellent Majesty in right of Her Crown, without the previous consent in writing of the Commissioners for the time being of Her Majesty's Woods, Forests, and Land Revenues, or one of them, on behalf of Her Majesty, which consent such commissioners, or one of them, may give.

18. The company shall not place any work under, in, or upon any land or building, except with the consent of the owner, lessee, and occupier, thereof; and, save as hereinafter expressly provided, the company shall not place any work over, along, or across any land or building, except with the consent of the owner, lessee, and occupier thereof.

19. Where the body having the control of a street consents to the placing of works in, upon, over, along, or across the street, that consent shall be sufficient authority for the company to place and maintain a telegraph over, along, or across any land or building adjoining to or near the

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street, and within the limits to which the authority of such body extends, —subject to this restriction, that where the company places a telegraph directly over any dwelling house adjoining to or near the street, they shall not place the same at a less height above the roof thereof than six feet, if the owner, lessee, or occupier of the dwelling house objects to their placing the same at a less height.

20. Subject and without prejudice to the foregoing provisions, the company shall not place a telegraph above ground, or a post, within ten yards of a dwelling house, (whether adjoining to or near a street or not), or place a telegraph above ground across an avenue or approach to such a dwelling house, except subject and according to the following restrictions and provisions:—

They shall in each such case obtain the consent of the occupier (if any, of such dwelling house, and if there is no occupier, then of the immediate lessee, and if there is none, then of the owner:

The consent of an occupier shall be effective only during the continuance of his occupation:

On the termination of the occupation of any occupier, the lessee or owner entitled to possession, if he did not consent to the placing of the telegraph or post, may give notice to the company that he requires it to be removed:

The company shall remove the same accordingly within one month after receiving such notice:

If any question arises between a lessee or owner and the Company as to such removal, or the time or mode thereof, the same shall be referred to the determination in England or Ireland of two Justices, and in Scotland of two justices or the sheriff, which justices or sheriff may give such directions as to such removal, and the time and mode thereof, as may seem reasonable, and may impose on the company for not carrying such directions into effect such penalty not exceeding five pounds a day as may seem just.

21. Before the company proceeds to place a telegraph over, along, or across a public road, or to place posts in or upon a public road, they shall publish a notice stating that they have obtained the consent in that behalf of the body having the control of the public road, and describing the intended course of the telegraph,—

By affixing such notice on some conspicuous places by the side of the part of the road affected, at distances of not more than one mile apart:

By leaving such notice at every dwelling house fronting on the part of the road affected, and being within fifty feet thereof:

By inserting such notice as an advertisement once at least in each of two successive weeks in some one and the same local newspaper circulating in the neighbourhood of the part of the road affected:

And they shall not so place any such telegraph or post until the expiration of twenty-one days from the last publication of such advertisement.

22. At any time during such twenty-one days the owner, lessee, or occupier of any land or building adjoining to either side of such road may give to the company notice of his objection to their intended works as injuriously affecting such land or building, and send to the Board of Trade a copy of his notice of objection.

23. Until such objection is settled, or is determined in manner hereinafter provided, the company shall not execute that part of their intended works to which the objection relates.

24. As soon as may be after the receipt of such copy of notice of objection, the Board of Trade shall (unless the difference between the company and the person objecting is arranged) make inquiry and examination, and hear and determine the matter of the objection.

25. On hearing any such objection the Board of Trade may allow the objection, wholly or in part, or may authorise the company to proceed with their works according to their published notice, paying to the owner, lessee, or occupier objecting full compensation (the amount thereof to be determined, in case of difference, by the Board of Trade) for any damage done to him; or may authorise the company to so proceed subject to any such conditions as to the time or mode of execution of any work, or as to the removal or alteration in any event of any work, or as to any other thing connected with or relative to any work, as the Board of Trade thinks fit; or may authorise the company to so proceed subject to any such modification of any intended work as the Board of Trade prescribes; but so that in that case such notice and opportunity of objecting and being heard as the Board of Trade directs shall be given to any owner, lessee, or occupier whom such modification may affect.

26. The determination of the Board of Trade on the matter of any such objection shall be final and conclusive.

27. The Board of Trade may allow to any owner, lessee, or occupier so objecting such costs as seem just, to be paid by the company.

Removal or Alteration of Works affecting Land or Buildings.

28. If at any time after the company has constructed any work under, in, upon, over, along, or across any land or building, or any street or public road adjoining to or near any land or building, any owner, lessee, or occupier of such land or building, or any lord of a manor, or other person having any interest in such land or building, desires to build upon or inclose such land, or in any manner to improve or alter such land or building, or to use such land or building in some manner in which it was not actually used at the time of the construction of such work by the company, and with which the continuance of such work would materially interfere, then and in every such case the following provisions shall take effect:—

Such owner, lessee, occupier, lord of a manor, or other person interested may give to the company a notice requiring them to remove or alter such work, and specifying the grounds of such requisition:

Within one month after such notice received the company shall either remove or alter the work, in accordance with the notice:

Nothing herein shall empower any person to obtain the removal or alteration of any work, the construction whereof was consented to by him, or by any person through whom he takes his estate or interest, for full and valuable consideration passing from the company to him or the person through whom he takes.

The present Section shall apply to any work already constructed under any special Act, with and subject to this additional provision—that the person obtaining the removal or alteration of any such work shall pay to the company compensation for any expense or damage incurred or sustained by them by reason of such removal or alteration, the amount thereof to be determined in case of difference, by the Board of Trade.

Restrictions as to Works affecting Railways and Canals.

29. The company shall not place any work under, in, upon, over, along, or across any railway or canal, except with the consent of the proprietors or lessees, or of the directors or persons having the control thereof. But this provision shall not restrict the company from placing any work (subject and according to the other provisions of this Act) under, in, upon, over, along, or across any street or public road, although such street or public road may cross or be crossed by a railway or canal, so that such work do not damage the railway or canal, or interfere with the use, alteration, or improvement thereof.

30. If at any time after the company has placed any work under, in, upon, over, along, or across any canal, any person having power to construct docks, basins, or other works upon any land, adjoining to or near such canal constructs any dock, basin, or work on such land, but is prevented by the company's work from forming a communication for the convenient passage of vessels with or without masts between such dock, basin, or other work, and such canal, or if the business of such dock, basin, or other work is interfered with by reason or in consequence of any such work of the company, then the company, at the request of such person, and on having reasonable facilities afforded them by him for placing a telegraph round such dock, basin, or other work, under, in, upon, over, along, or across land belonging to or under his control, shall remove and place their work accordingly. If any dispute arises between the company and such person as to the facilities to be afforded to the company, or as to the direction in which the telegraph is to be placed, it shall be determined by the Board of Trade.

Appointment of Arbitrator by Board of Trade.

31. If in any case where any matter is hereinbefore authorized or directed to be determined by the Board of Trade it appears to the Board of Trade to be expedient, for convenience of local investigation or for any other reason, that the matter should be determined by an arbitrator, the Board of Trade may, notwithstanding anything hereinbefore contained, and whether the Board of Trade has entered on the investigation or not, refer the matter to some competent and impartial person as arbitrator; and with respect to the matter so referred any such arbitrator shall have the like authority and jurisdiction as the Board of Trade has under this Act, and his determination shall have the same effect as a determination of the Board of Trade under this Act. The reasonable expenses and remuneration of the arbitrator (to be settled in case of difference by the Board of Trade) shall be paid by the company.

Restrictions as to Works affecting Seashore.

32. The company shall not place any work under, in, upon, over, along, or across any estuary or branch of the sea, or the shore or bed of any tidal water, except with the consent of all persons and bodies having any right of property, or other right, power, jurisdiction, or authority in, over, or relating to the same, which may be affected or be liable to be affected by the exercise of the powers of the company (which consent, where Her Majesty in right of her crown is interested, may be given on behalf of Her Majesty by the Commissioners for the time being of Her Majesty's Woods, Forests, and Land Revenues, or one of them, in writing signed by them or him).

33. Before commencing the construction of any such work as last aforesaid, or of any buoy or sea mark connected therewith, except in cases of emergency for repairs to any work already constructed or laid, and then as speedily after the commencement of such work as may be, the Company shall deposit at the office of the Board of Trade a plan thereof, for the approval of the Board of Trade. The work shall not be constructed otherwise than in accordance with such approval. If any work is constructed contrary to this provision, the Board of Trade may, at the expense of the company, abate and remove it, or any part of it, and restore the site thereof to its former condition.

34. If any such work, buoy, or sea mark is abandoned, or suffered to fall into decay, the Board of Trade may, if, and as they think fit, at the expense of the Company, either repair and restore it, or any part of it, or abate and remove it or any part of it, and restore the site thereof to its former condition.

The Board of Trade may, at any time, at the expense of the company, cause to be made a survey and examination of any such work, buoy, or sea mark, or of the site thereof.

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Whenever the Board of Trade, under the authority of this Act, does, in relation to any such work, any act or thing which they are by this Act authorized to do at the expense of the company, the amount of such expense shall be a debt due to the Crown from the company, and shall be recoverable as such, with costs, or the same may be recovered, with costs, as a penalty is or may be recoverable from the company.

General Obligations and Liabilities of Company and their Servants.

37. Every telegraph of the company shall be open for the messages of all persons alike, without favour or preference; but this provision shall not prejudicially affect the operation of any lease authorized by this Act.

38. The company shall be answerable for all accidents and injuries happening through the Act or default of the company or of any person in their employment by reason or in consequence of any of the company's works, and shall save harmless all bodies having the control of streets or public roads, collectively and individually, and their officers and servants, from all damages and costs in respect of such accidents and injuries.

39. The company shall not sell, transfer, or lease their undertaking or works, or any part thereof, to any other company or to any body or person, except with the consent of the Board of Trade previously obtained for such sale, transfer or lease; but this provision shall not, as far as it relates to leases, apply to the Universal Private Telegraph Company, constituted by the Special Act of 1861 in the schedule to this Act mentioned, and shall not restrict the granting of any lease by any company in pursuance of any agreement in that behalf made before the twelfth day of February, one thousand eight hundred and sixty-three.

40. If any person in the employment of the company—

Wilfully or negligently omits or delays to transmit or deliver any message;

Or by any wilful or negligent act or omission prevents or delays the transmission or delivery of any message;

Or improperly divulges to any person the purport of any message,—

He shall for every such offence be liable to a penalty not exceeding twenty pounds.

41. Nothing in this Act, and nothing in any future special Act, except so far as express provision to the contrary hereof may be thereby made, shall relieve the company from being subject to any restrictions, regulations, or provisions which may hereafter be made by Act of Parliament respecting telegraphs or telegraph companies or their charges.

Saving as to Restrictions on and Duties of existing Companies.

42. Nothing in this Act shall affect any of the enactments specified in the schedule of this Act.

Powers of Her Majesty's Government over Company.

43. If one of Her Majesty's principal Secretaries of State, or the Board of Trade, or any other department of Her Majesty Government, requires the company to transmit any message on Her Majesty's service, such message shall (notwithstanding anything hereinbefore contained) have priority over all other messages; and the company shall as soon as reasonably may be transmit the same, and shall, until transmission thereof, suspend the transmission of all other messages.

44. On the request of the Board of Trade, the company shall from time to time place and shall maintain such a telegraph as the Board of Trade appoints, to be for the exclusive use of Her Majesty, and to be applied to such purposes, whether for the immediate service of Her Majesty, or otherwise, as Her Majesty thinks fit.

45. If the company refuses or neglects to place a telegraph in accordance with such request, the Board of Trade may cause such a telegraph to be placed in connection with any of the company's works, by such persons and in such manner as the Board of Trade thinks fit, and for that purpose shall have and may exercise all the powers under this Act or otherwise vested in the company; subject, nevertheless, to the restrictions and provisions under this Act or otherwise applicable to the company, and without prejudice to the exercise by the company of the powers under this Act or otherwise vested in them.

46. Where the company places a telegraph, in pursuance of such request of the Board of Trade, the Commissioners of Her Majesty's Treasury shall pay to to the company, as remuneration for the same, out of money to be provided by Parliament for the purpose, such sum, annual or in gross, or both, as may be settled between the Board of Trade and the company by agreement, or in case of difference, by arbitration, such arbitration to be conducted as follows;—

The Board of Trade and the company shall each, within fourteen days after the delivery by one to the other of a demand in writing for an arbitration, nominate an arbitrator:

If either party makes default in so nominating an arbitrator, the arbitrator nominated by the other party shall nominate a second arbitrator:

The two arbitrators nominated shall, before entering on the arbitration, nominate an umpire:

If either party makes default in nominating an umpire within fourteen days after receiving from the other a demand in writing for such nomination, the Lord Chief Justice of Her Majesty's Court of Common Pleas at Westminster may, on the request of the Board of Trade, or of the company, by writing under his hand, nominate an umpire:

The arbitrators shall make their award within twenty-eight days after their nomination, otherwise the matter shall be left to be determined by the umpire:

The umpire shall make his award within twenty-eight days after notice from the arbitrators or one of them that the matter is left to be determined by him; or, on default, a new umpire shall be appointed as nearly as may be in manner aforesaid, who shall make his award within the like time, or in default be superseded; and so toties quoties.

The award of the arbitrators or umpire shall be final and conclusive as between the Board of Trade and the company.

47. Where, in the opinion of one of Her Majesty's Secretaries of State, an emergency has arisen in which it is expedient for the public service that Her Majesty's Government should have control over the transmission of messages by the company's telegraphs, the Secretary of State, by warrant under his hand, may direct and cause the company's works, or any part thereof, to be taken possession of in the name and on behalf of Her Majesty, and to be used for Her Majesty's Service, and, subject thereto, for such ordinary service as may seem fit; or may direct and authorize such persons as he thinks fit to assume the control of the transmission of messages by the company's telegraphs, either wholly or partly, and in such manner as he directs. Any such warrant shall not have effect for a longer time than one week from the issuing thereof; but the Secretary of State may issue successive warrants from week to week as long as, in his opinion, such emergency continues. The Commissioners of Her Majesty's Treasury shall pay to the company as compensation for any loss of profit sustained by the company by reason of the exercise by the Secretary of State of any of the powers of the present section, out of money to be provided by Parliament for the purpose, such sum as may be settled between the Secretary of State and the company by agreement, or, in case of difference, by arbitration—such arbitration to be conducted in manner provided in the last foregoing section, the Secretary of State being only substituted for the Board of Trade.

48. Where it appears to the Board of Trade that any provision of this Act has not been complied with on the part of the company, and that it would be for the public advantage that compliance therewith should be enforced, the Board of Trade may certify accordingly to Her Majesty's Attorney General for England or for Ireland, or to the Lord Advocate for Scotland as the case may require; and thereupon the Attorney General or Lord Advocate may, by such civil or criminal proceeding as the case may require, enforce compliance with such provision, by the recovery of penalties, or otherwise according to law. But no certificate shall be made by the Board of Trade until twenty-one days after they have given notice to the company of their intention to make the same. This provision shall be deemed to be cumulative, and to be without prejudice to any other remedy or process against the company on the part of Her Majesty or of any person or body.

SCHEDULE.

Enactments in Special Acts of existing Companies which are not to be affected by this Act.

Session and Chapter of Act.	Short Title of Act.	Enactments to which Saving extends.
16 & 17 Vict. c. clix.	The British Electric Telegraph Company's Act, 1853.	Section Forty-three (relating to Works affecting the Thames).
16 & 17 Vict. c. ccciii.	The Electric Telegraph Company's Act, 1853.	Section Fifty-six (relating to Works affecting the Thames).
24 & 25 Vict. c. lxi.	The Universal Private Telegraph Company's Act, 1861.	Section Twenty-seven (relating to Works affecting the Mersey Dock Estate).
24 & 25 Vict. c. xcii.	Bonelli's Electric Telegraph Act, 1861.	Sections Twenty-five, Twenty-six, Twenty-seven (relating to Works affecting the Thames), and Thirty-eight and Thirty-nine (relating to Works affecting the Mersey, and to the Mersey and Irwell Navigation).
25 & 26 Vict. c. cxxxi.	United Kingdom Electric Telegraph Act, 1862.	Sections Fifty-three, Fifty-four, Fifty-five (relating to Works affecting the Thames), Fifty-seven, Fifty-eight (relating to Works affecting the Mersey, and to the Mersey and Irwell Navigation), Seventy-four (relating to a Sale, Transfer, or Lease), and Seventy-six (relating to Works in Scotland).

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TELEGRAPH SHARES.—*Thursday's Quotations.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	65 to 69	
Stock	Electric Telegraph . .	100	100 to 102	
5	London District Telegraph .	all	2 to 2¼	
10	Mediterranean Extension Tel.	all	3 to 4	
1	Submarine Telegraph, scrip. .	all	⅜ to ⅝	
2	Telegraph to India (limited) .	1	¾ to ⅞ dis.	
5	United Kingdom Telegraph .	8	par to ½ pm.	

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	... 1s. 11d.	per lb.
Second „	... 1s 5d. to 1s. 8d.	„
Third Negro	... 1s. 1d. to 1s. 2d.	„
Java	... 1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine none worth	... 2s. 8d. and above.	
Genuine mixed	... 1s. 9d. to 2s.	per lb.
Reboiled good	... 1s. 5d. to 1s. 8d.	„
Ordinary ditto	... 1s. 0d.	„

April 23, 1863. Wm. Kirkmann,
4, Howford Buildings, Fenchurch Street, E.C.

INDO-AUSTRALIAN OVERLAND AND SEA LINES.

The rapid and successful development of the science of telegraphy in our colonial possessions has been often referred to in the columns of this journal. This week our readers will have an opportunity of perusing some valuable detals relating to our present subject-matter, and forwarded for publication from South Australia. It appears that the great question of an Indo-Australian telegraph is being fairly and seriously discussed, especially after the triumphant results of the recent explorations across the vast continent of Australia. There have been several proposals made to secure telegraphic communication between the flourishing colonies of Southern Australia and India; but in the absence of reliable information as to the nature and character of the country between its southern and northern extremities, a line of coast submarine telegraph was alone considered practical. One of our esteemed colonial correspondents writes as follows:—

"Central Australia is no longer *terra incognita*. It has been crossed and recrossed repeatedly by the recent exploring expeditions, and it is only a few months since that the citizens of Adelaide had to welcome the return of Mr. M'Kinlay, who, starting from that city, crossed to the shores of Carpentaria, and thence turned eastward to Moreton Bay, encountering no difficulty of sufficient importance to trouble an experienced bushman, and finding a considerable extent of country available for pastoral purposes, most of which will, undoubtedly, be occupied within the next few years. And, still more recently, the return of the brave and veteran explorer, Mr. J. M'Donald Stuart, after having successfully crossed the continent, and planted his flag on the beach of Van Dieman's Gulf, a little to the east of Cape Hotham, 131° 30′ E., 12° 15′ S.; having also, on two former trips, got within a few days' journey of the Victoria River, has demonstrated the practicability of an overland route from Adelaide to the north coasts of Australia. Already some of the wealthy and enterprising colonists are taking steps to send large herds of cattle and sheep across, with a view to the formation of a settlement in Arnheimland, and there are already cattle runs extending 600 miles north of Adelaide; while, on the Queensland side, should that be thought the best starting point for the telegraph line, the country is being rapidly taken up in the direction of Carpentaria, so that in a very few years the land through which it is proposed to carry the line would nearly everywhere be occupied for pastoral purposes, and in all cases the Government would find it to its advantage, in granting leases for runs traversed by the line, to make it a condition that the lessee should afford assistance to keep it in repair."

The *Sydney Morning Herald*, in a very able article upon colonial progress, has the following remarks:—

"The South Australians seem eager to turn Stuart's discovery to practical account. The people and the Government, it appears, are equally ready to assume the responsibility of exercising authority over all the territory due north of their present colony. Parties are said to be organising to send mobs of horses forward for shipment to India from Van Diemen's Gulf, a very favourable point from which to conduct the trade. They still further propose, as a matter of sober earnest, to construct a line of electric telegraph right across the continent from south to north along Stuart's route, from Adelaide, on the south to the Adelaide River on the north, from their present commercial metropolis to what may become the commercial metropolis of a new colony. The Government are preparing a bill to submit to Parliament to authorise the construction of this line. Mr. Todd, the superintendent of telegraphs in South Australia, is an energetic and go-ahead sort of man, and, indeed, may be considered as the father of overland telegraphs in Australia. He is not one of those officials who find difficulties everywhere, and who put buts and ifs in the way of every forward movement that is suggested. If the project on being closely studied is feasible at all, there is no one better fitted to see it carried out. If this line should be made, it will set at rest at once Mr. Gisborne's project for a submarine line round the coast. If Mr. Todd can carry a land line from Adelaide to Van Diemen's Gulf, the only submarine line Australians will have to concern themselves with will be that from the north coast to the Dutch islands—either Coepang or Bangoewangi."

Recent Patents.

2124. J. H. Selwyn, Grassmere, "*Apparatus employed in paying out and raising electric telegraph cables.*" Dated 26th July, 1862.

For the purposes of this invention, in paying-out and raising electric telegraph cables, a buoy is used which is kept constantly at a distance from the machinery or apparatus employed for paying-out or raising the telegraph cable, in order that, in the event of the telegraph cable breaking, the broken end may, after it has left the paying-out or raising machinery, have to travel a considerable distance before it can arrive at the buoy. By this arrangement time is allowed after the breaking of the cable for apparatus which the buoy carries to come into action and prevent the passing away of the broken end of the cable. The apparatus above-mentioned is suspended from the buoy, so as to hang at a distance below the surface of the water, and it contains two grooved pulleys which constantly support the cable as it is running out, or is being drawn in. The bearings of one of these pulleys are movable, so that the pulley can traverse a certain distance. When the cable breaks, and the broken part descends into the water and sinks, it brings the cable as it comes up to the movable grooved pulley above mentioned to a different angle to that at which it previously passed to this pulley, and then the drag of the cable will cause the said pulley to rise towards a third grooved pulley, which is situated above the telegraph cable, but somewhat behind the rising pulley, and thus the cable will be tightly held between the lower and upper pulleys. In order that this result may be obtained, the axis of the rising pulley is carried in inclined slots or grooves, while the bearings of the axis of the upper grooved pulley are fixed and stationary. The three pulleys and their axes are carried by a suitable frame, which is at its upper end connected to the buoy by a short rope or chain.

2131. P. S. Devlan, Manchester, "*Manufacture of telegraphic cables.*" Dated 28th July, 1862.

The cable constructed according to this invention consists of a number of insulated wires, collected and arranged together to form the cable, and is designed for the purposes of flexibility, durability, tenacity, and strength. The improvement consists in coating the wires to be insulated with a composition consisting of about 8lb. of paper, or rather fibrous pulp, half a pound of caoutchouc or gutta percha, with 1lb. of resin, or thereabouts. The composition is thus applied:—The inventor takes one or more of the

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ordinary constructing wires, over which he puts a complete coating of the composition in any required thickness; this coating of the composition is put on while the latter is in a soft condition, and may be applied by suitable dies or drawing machines for the purpose. When the coating has become sufficiently dry, he braids or plaits over it a coating of fine strong cord; over this covering of cord he applies another coating of the composition, and over it another cord covering, and so on until the cable is completed. Not proceeded with.

2238. H. Fenton, Queen's Ferry, Lancashire, and W. Stubbs, Liverpool, "*Telegraph wires.*" Dated 11th August, 1862.

This invention consists in first covering the wires with a thin covering of copper, by immersing them in a bath containing a solution of copper, or in any other convenient way, and afterwards applying a coating or coatings of asphalte, black varnish, or of any other like suitable non-conductive substance or substances. Not proceeded with.

3061. F. S. Ritchie, Brookline, Massachusetts, U.S., "*Mariner's compass.*" Dated 13th November, 1862.

The object of this invention is not only to dispose of a mariner's compass out of, or more or less beyond the, attractive influence of iron on or about the deck or other part of a ship or navigable vessel, but to enable the movements or operations of the compass card, or the magnet or magnets of the compass, to be easily read or indicated, either at, near, or below the deck, or at any convenient distance below the compass. The invention is applicable to liquid compasses, and particularly to such as are provided with an air vessel combined with a magnet, or the same and its card, in manner so as not only to encompass the magnet and insulate it from the surrounding liquid, but also to buoy up the magnet or magnets and card, in order to remove more or less of the weight thereof from the supporting pivot or bearing. The nature of the invention consists in the combination of an auxiliary annular air vessel or indicator, and a connecting rod or mechanical equivalents therefore, with the magnet or magnets on the same, and its or their buoyant air vessel, the whole being arranged in a case or vessel to contain water or other proper fluid, and so as to operate together substantially as specified. And the nature of this invention further consists in the combination of either or both of the buoyant air vessels with their shaft, by means of gimbals or their mechanical equivalents. And the nature of this invention further consists in the combination of an auxiliary buoyant chamber, or its equivalent, with the said connecting rod, or connector, the magnet, or the same and its buoyant case, and the auxiliary case or indicator, as arranged within a vessel or case containing a liquid, and so as to operate therein substantially as specified. And the nature of the invention further consists in a peculiar arrangement of the cardinal divisions or indications with respect to the float or indicator, when made either circular or cylindrical in form, or as an annulus, substantially as described.

2297. C. E. Spagnoletti, Great Western Railway, Paddington, "*Apparatus for signalling trains on railways.*" Dated 14th August, 1862.

For the purpose of signalling trains on railways from one point to another when a train passes, and when the line becomes clear, the patentee employs instruments each having a dial and two finger keys. In connection with the dial is a magnetic needle surrounded with coils of insulated wire, and having mounted on it two screens; on one of these are written the words "line clear," and on the other the words "train on the line," and the screens are so arranged in connection with a hole in the dial plate, behind which they work, that, when the needle inclines to one side, the notice on the screen on one side of the needle becomes visible, and, similarly, when the needle inclines to the other side the notice on the other side is red. The screen, with the notice "line clear," he colours white, and the screen with the notice "train on the line," he colours red, so that the signalman may readily see from a distance how the needle is standing. The finger keys of the instrument are similarly coloured, and the parts are arranged so that depressing the red finger key will make such contact as will cause a current of electricity to pass from the battery which works the instrument through the coils around the magnetic needle in such a direction as to cause the said needle so to incline as to show the words, "train on the line," on the red screen. By depressing the white finger key, a current of electricity will be similarly caused to traverse the coils, so as to cause the needle to incline in such a manner as to show the words, "line clear," on the white screen.

2334. S. J. Paris, Manchester, and W. Bate, Salford, "*Alphabetical electric telegraphs.*" Dated 21st August, 1862.

The documents relating to this invention are with the law officers under objection, and cannot at present be seen.

2432. Sir W. O'S. Brooke, Easton-place, London, "*Construction of submarine telegraph cables.*" Dated 2nd September, 1862.

The object of this invention is so to construct a marine telegraphic cable for deep-sea lines that its specific gravity, and, consequently, its rate of sinking as it is laid can be regulated with precision; and a further object of the means of construction which the inventor adopts is the protection, at the same time, of the telegraphic core against friction and other ordinary causes of mechanical injury. The objects are attained by the use of wooden tubes, which are threaded on to the telegraphic core. For the construction of the tubes American beech is preferred, impregnated with drying oils or melted paraffine under great pressure. The usual length of the tubes is 4 inches, and the usual diameter 1 inch, but these dimensions may vary and other woods may be used. The core is enclosed in hemp or silk lines, rendered waterproof, and preserved by any suitable preparations, and coated with tape. Between the ends of the wooden tubes are interposed elastic discs or joints of caoutchouc, flexible or vulcanite canvas prepared with caoutchouc, leather or hemp saturated with paraffine, wax, marine glue, or other oleaginous or resinous substances; or other flexible material may be employed, the object being to give flexibility to the sable with due protection to the core. To regulate the rate of sinking there may be interposed at certain intervals tubes of iron-wood, lignum vitæ, or other dense woods, or of marble, instead of the ordinary tubes of wood lighter than sea water. Not proceeded with.

2591. J. Mapple, Kentish Town, and D. Mapple, Homerton New Town, "*Telegraphic apparatus.*" Dated 23rd September, 1862.

This invention consists of a flat endless chain rotated by a train of clockwork, and in its rotation it is made to rub against an inking roller supplied with printing ink, and so forming a tracer. A strip of paper is likewise carried forward by the said clockwork, and the strip of paper is made to rub continuously against the tracer, and the contact of the tracer with the paper is broken; or the paper is pushed away from the tracer, as may be desired, to give the signals by the attractive force of an electro-magnet, which magnet pulls an arm down and presses the paper away from the tracer, in contradistinction to William Spence's patent communicated to him by Digney Fréres (No. 279) of 1858, in which the arm moved by the electro-magnet presses the strip of paper against the tracer. The inventors purpose reading the telegrams by the white spaces instead of the inked lines of other tracing instruments, as by this arrangement the instrument is capable of being worked with a smaller amount of power than any other tracing instrument. Not proceeded with.

2619. A. Potter, Birmingham, "*Electro-magnetic engines.*" Dated 25th September, 1862.

This invention relates to the means of obtaining electro-magnetic motive power by direct rotary motion, and the engine consists of a fixed circle or band of soft iron bars screwed straight across the inside edges of two or more stout wheels; the widths of these bars are to correspond with the thickness of the covers of the electro-magnets to be used; the distance between each bar is to be double that of the width of the bars themselves, and the number of bars to be used in the circumference of the wheels may vary according to the measurement of the circumference, which measurement must be equally divided by the thick of the cores of the electro-magnets. The axle or shaft of the engine is to be set in bearings supported by standards from the foundation plate, and its centre will be also the centre of the circle bars which form armatures for the electro-magnets attached in radial lines to the central shaft. The lengths of the armatures may be varied so as to allow of several electro-magnets being attached to the shaft side by side in the same radial line, and form an engine of greater breadth. There should be three, six, or any multiple of three electro-magnets, fixed on the axle, that is to say, such number of radial magnets, although each radius or series may consist, as before stated, of one, or more than one, magnet on the axle, each in the same plane; and they are to be of such length as to rotate as close as possible to the armatures, but without actual contact. The invention relates also to a break for connecting and disconnecting the electric current. Not proceeded with.

Telegraphic News.

SUBMARINE TELEGRAPHY.

The Council of the Society of Arts, in accordance with the suggestion of Sir E. Belcher, has appointed a committee to inquire into the subject of submarine telegraphy. The committee consists of the following gentlemen, viz.:—Abel, F. A., F.R.S.; Brooke, Charles, F.R.S.; Donnelly Capt., R.E.: Galton, Capt. Douglas, F.R.S.; Grove, W. R., A.C., F.R.S.; Hamilton, Edward, Esq.; Miller, Professor W. A., F.R.S.; Phillips, Sir Thos., F.G.S.; Sabine, Major-Gen., F.R.S.; Sopwith, Thomas, F.R.S.; Spottiswood, W., F.R.S.; Webster Thomas, F.R.S.

SUBMARINE TELEGRAPH.

An extraordinary meeting of this company was held on Tuesday last, at the London Tavern, Sir J. Carmichael in the chair.

The Chairman said the object of the meeting was to ascertain the opinions of the shareholders with regard to the payment of a dividend

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for the second half of 1862, and for raising more capital. The dividend was entirely a shareholders' question. The directors had recommended a dividend because it had been earned, and it was for them to decide whether they would take it or strengthen the hands of the directors by leaving that money to be invested as a reserve.

Mr. Horton said it had been stated at the last meeting that the cables would have to be renewed every ten years, which would require a very large reserve.

Sir C. Bright said he did not mean to state that the company's lines would have to be replaced every ten years, although a great deal of depreciation was going on. Provision should be made for that depreciation.

Mr. Francis, the engineer of the company, said it was quite true about the depreciation. There was a line round the coast extending some eight or nine miles out, which was of hard chalk. In the Straits of Dover the cables got the most wear, but further out there was a sand bottom, and the cables being embedded in sand were more protected. The Calais line had only been broken once in twelve years, and the Ostend had never been broken beyond the nine miles out. The gutta percha depreciated to a certain extent, the depreciation being less under the sand than under the water.

The Chairman said, after the issue of the additional capital, and getting rid of the present loan, they would be able to pay the same dividend on the old and new stock as they were now paying, and the company would be out of debt. He moved a resolution authorizing the issue of the new capital, and it was carried. A resolution was then agreed to authorizing the payment of the dividend recommended at the last meeting, and the proceedings terminated.

Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

To the Editor of the Electrician.

Sir,—One would hardly imagine, to read "Relay Magnet," that the "setting Mr. Laming right" only proved him to have been in error to the extent of omitting on a certain occasion to take into account one of his own previously published doctrines! I look upon the circumstance I am about to mention as more worthy of your correspondent's regard, after all I have laid before competent electricians at large, in the pages of your journal, on the subject of doctrinal electricity; and though my principles of electrical action are essentially original, no one has pointed out in them a single discrepancy with fact. Will "Relay Magnet" think it worth his while to ponder that? But I have not yet furnished the information he is demanding of me, and with which I fear he will be disappointed. He will be still outraging a physical law, even if he be granted all the "adequate sources" that could be reconciled to the doctrines of his leader, Ohm. The term "adequate source" must mean one of two things. In hydraulics two sources may be both adequate to supply quantities, one fully equal to the capacity of a sewer, and the other only barely sufficient for a hollow straw; the "heads" of water, or pressure, in the two sources being equal. Such an adequate source will not serve his purpose. And for the straw to deliver as much water in a given time as the sewer, it must have something beside an equally abundant source of supply; to be "adequate" it must have a "head" so much higher than the other as to —shall I say burst open the channel? Well then, to save the circumlocution that might be introduced under a metaphor, I will put the fact as it occurs to an electrician; when he passes as much electricity in a given time through a fine wire as can be passed through another much larger, not only must the source be adequate in the sense of supplying an equal quantity, but in another sense also; that quantity must be entering the finer wire under a much greater head of force, for the resistance will be increased, and greater resistance can only be compensated for by higher motive tensions; observation teaches, in conformity with this, that if the voltaic elements be large, to afford quantity of electricity, and numerous in series, to supply high motive tension, one of two wires may be so much smaller than another as to be shivered to atoms long before the quantity of electricity forced along it becomes equal to what the other might convey without suffering disintegration.

Now this latter kind of adequacy is not available to "Relay Magnet" unless he be actually discriminating in a manner forbidden by his school, to whose founder a Copley Medal has been awarded for physically confounding quantity with tension. Practically, telegraphists know that they can do with intensity what they cannot do without it; but they know too that a given quantity of electricity, existing under given circumstances, has the same powers, whether, in taking up the existing position, it have fallen from a former intensity or not; the two facts are equally important, and of course both reconcilable to true doctrine; but, ignoring the one, the followers of Ohm seem to act upon the other as though it were an uncontradicted evidence that intensity and quantity are *intrinsically* one and the same.

Richard Laming.

To the Editor of The Electrician.

Sir,—Whatever may be the truth of Mr. Preece's theory of the square as applied to electricity, there is, I believe, no doubt that the magnetic force varies inversely as the square of the distance of the two objects between which it may be exerted; if the distance inversely as the square of which the magnetism varies be measured from the surfaces of the two bodies, it seems to me that it might be mathematically proved that no two material surfaces touch one another—or at least that the two bodies drawn together by the magnetic force do not. For if we take D to represent the distance between two bodies which are being drawn together by magnetic force with a power F, then, by the rule of the square, as $0' : D' :: F :$ force exerted when the bodies are in actual contact, as when the distance is zero, but $0' : D' :: F :$ infinity, consequently, were the bodies in actual contact the force extended would be infinite, and they would never come apart. Of course all this hangs upon the question of whence the points of measurement are to be taken; it might also be that actual contact would set up some counter force. All this I cannot tell, but if there be anything new in the idea I should be much obliged by the insertion of this letter, as it would insure the attention of some one better acquainted with the subject.—I am, sir, yours very truly, Harry W. Cook.

25, *Sunderland Terrace, Westbourne Park, W.*

Miscellanea.

Influence of Heat on the Voltaic Battery.—M. Carlo Roberti, of Verona, in a note forwarded to the Academy of Sciences, at Paris, states that, while pursuing some experimental researches with Gauss's apparatus, he was struck, first, with the irregularity, and afterwards with the progressive periodical intensity of the pile he employed. He was soon led to attribute this to the variation of the temperature due to the hourly advance of a solar ray which had penetrated his laboratory. He immediately conceived the idea of applying the fact to the electric telegraph, and other purposes, and states that he is now engaged in rigorous experiments with the view of arriving at the exact numbers which establish the advantages that may be derived from the phenomenon.

Equality in the length of the arms of the lever is, of course, the most important consideration in the construction of the balance; but when there may be any reason to doubt this essential point, it is well to know that any error may be avoided by the method of *double weighing*. This consists in placing the object whose weight is to be ascertained in one scale-pan, and exactly counterbalancing it in the other, not with the weights, but with sand or shot, or any other indifferent substance. It is then removed, and the weights applied in the same pan, till the counterpoise is balanced. By this contrivance the unknown quantity of matter is compared with the known, under exactly equal circumstances, and the result is independent of almost every source of error which can affect the comparison of one object with another. An object may also be correctly weighed in an incorrect balance by changing the object and the weights from one pan to the other. The mean of the two weighings may be mathematically proved to be correct.

The Ratan Cane.—As the use of this material for the outer covering of submarine cables has recently engaged considerable attention, the following analysis of this material will be of some interest:—The entire cane yields 8·03 per cent. of ash, having the following composition:—Silica, 76·04; sulphuric acid, 7·36; potash, 7·30; soda, 6·86; lime, 2·37; with traces of iron, manganese, magnesia, and phosphoric acid. The outer portion of the cane, sliced off with a knife, yields 40·04 per cent. of ash, of which 97·07 per cent. is silica. The remainder of the cane, from which the exterior had been sliced off, yields 2·40 per cent. of ash, of which 28·26 per cent. is silica. The substance of the cane is made up of cellular tissue, with irregularly interspersed bundles of woody fibre, or, more correctly, of fibro-vascular tissue. The cuticle of the cane consists of flattened, closely-adherent cells, filled with silica, so as to form a complete siliceous sheath to the whole.

To Correspondents.

To Subscribers.—Our next Number will complete the Third Half-Yearly Volume. Covers for binding, uniform with the First and Second, may be had of the Publisher. A few complete sets may be had.

J. Cook.—Your proposed form of commutator could not be *thoroughly* explained without the aid of several diagrams; but we shall at an early opportunity refer to the principle. You have not, we presume, tested it practically, so as to be able to inform us whether the contacts are efficient and can be depended upon, and whether the instrument is readily constructed.

Advertisements and Communications for the Publisher, for the current number to be addressed to the Office, 32, Paternoster Row, not later than 1 o'clock every Wednesday. Post Office Orders to be made payable to Mr. Thomas Piper, at the Money Order Office, St. Martin's-le-Grand.

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The Electrician.

VOL. III. No. 78.—MAY 1, 1863.

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ELECTRO-PHYSIOLOGY.

BY HARRY WILLIAM LOBB, L.S.A., M.R.C.S.E., &C.

IN Bernard's experiment of dividing the sympathetic in the neck (corroborated by Handfield Jones and Brown-Séquard), that side of the head inflames; in other words, a larger supply of blood is attracted to the part: the ear and eye become red, are hotter than on the opposite side, even to twenty degrees Fahrenheit; and. if the animal be a weakly one, suppuration of the conjunctiva may supervene.

There have been various reasons adduced to account for these phenomena, M. Brown-Séquard's being, that the sympathetic controls the muscular coats of the arteries, and when the nerve is divided upon one side, those vessels which received their nerves from the divided trunk are paralysed and dilate, allowing a larger supply of blood to pass the part. This is an admirable remark, and worthy of the great experimenter to whom we are indebted for it; still, I believe it to be only half the truth, the other half being, as I have explained in the introduction to "Nervous Affections" p. 70, "The sympathetic system of nerves above the portion severed is nearly cut off from the centre . . . . the part itself having its vitality nearly under its own control, it is not affected by what is going on elsewhere; it does not *know* that the stomach, the spleen, or the liver may want a larger supply of blood, therefore it takes all it can get for its own nutrition; more blood is attracted to the part; tissue change goes on rapidly; even stasis may take place, and suppuration be the result, the blood not knowing that it is required elsewhere, from the communication with the centres being for the most part cut off."

"If, however, the nerve be galvanised, we find a very different state of things; the blood circulates more rapidly; the capillaries, instead of attracting and retaining the blood, pass it on and there is an opposite condition of the part; it may become even colder than on the other side. Here the centre has excess of power over the peripheral corpuscles, and the blood is not allowed to accumulate in the part, but is sent on;" also, the muscular coats of the arteries contract upon the blood and force it onwards. "We arrive at this rule—that where the centres are powerful, blood is not allowed to accumulate in the periphery except where required. When the centres are weak, blood accumulates in the periphery, and over-action occurs in the part," &c.

These observations are of the greatest value in leading us to a rational method of employing galvanism, as we are enabled, in treating affections of the sympathetic system, to apply with confidence a direct or inverse current, according to whether we wish to stimulate a part, or, on the other hand, to counteract hyperæsthesia.

The following observations of the effects of the different descriptions of galvanic currents upon the nerves, are collected from the writings of the most distinguished experimenters in this field of inquiry. Professor Matteucci, followed by M. Dubois Reymond, have distinctly proved that electric currents circulate in the muscles of live animals, independent of the spinal cord and spinal and crural nerves, even if the animal be deprived as much as possible of all the nervous filaments ramifying in the muscles; consequently the electro-motor element is reduced to the muscles themselves.

There can be little doubt that powerful electrical currents exist in the muscular system of all animals. The first philosophers, from Matteucci to Dubois Reymond, from Humboldt to Becquerel, have allowed this. Professor Matteucci, than whom there is no greater authority in electrical physiology, gives the following as the laws supervising the muscular currents:—

The intensity of the currents varies according to the temperature of the medium in which the animal has lived.

The duration of the currents after death is so much the less as the animal is raised in the scale of creation.

The intensity varies with the degree of nutrition of the muscle, and is always strongest in those muscles which are gorged with blood and inflamed.

They are altogether independent of the integrity and activity of the motor and sensorial nervous systems.

The influence of narcotic poisons is null, or very feeble, on this current.

That the current proper of the frog persists in its intensity and direction without the spinal cord, or the spinal and crural nerves, and even if the animal is deprived of all the nervous filaments of the muscular mass of the thigh.

That the electro-motive element of this current is confined to the muscles of the leg and of the thigh organically united.

Below will be found the opinion of the illustrious Humboldt upon the muscular current:—

"At a meeting of the Academy of Sciences, M. Arago read the following note from the illustrious Humboldt:—

"'Neither the jeers of certain editors on German credulity, nor the negative results obtained by two of our first natural philosophers, have changed my convictions regarding the influence of muscular action on the movement and direction of the galvanic needle. We have recently repeated our experiments at M. Reymond's, and I invited M. Mitscherlich to attend, knowing his great dexterity in the management of delicate instruments. On giving tension to the muscles of the left arm, the needle was instantly made to move by M. Mitscherlich, and that in the direction predicted by M. Reymond; viz., one indicating a current from the hand to the shoulder of the arm which was in action. On stiffening his right arm, M. Mitscherlich made the needle move in an opposite direction, and traverse a smaller number of degrees; this arises from the fact that the energy of muscular contraction is not always the same in both arms. Occupied as I have been for more than half a century with physiological researches of this kind, the discovery of M. Reymond has deeply interested me. It is a vital phenomenon rendered sensible to us by an instrument of physics.'

"In connection with the same subject I may mention the result of some curious experiments recently made by M. Ducros. The conductors of a galvanometer were applied, one to the forehead and the other to the neck. The needle remained steady and marked forty degrees. The patient's thigh was now strongly pinched, and, under the influence of the pain, the needle passed to eighty degrees with great rapidity. The experiment, frequently repeated, gave the same results; and M. Ducros hence concludes, 'that all causes which increase vital activity react on the galvanic needle at a distance from the point of their immediate action."

Mr. Rutter has still more admirably proved the existence of these muscular currents, (see his work on Human Electricity). He has devised an apparatus consisting of two bowls filled with water; at the bottom of each bowl is a metallic handle, communicating by a wire with an extremely delicate galvanometer. Upon placing the hands gently upon the handles, the needle of the galvanometer is not deflected, but upon contracting the muscles of the arm, the needle is sensibly affected in one direction; and the muscles of the other arm being contracted, the needle is deflected in the opposite direction. This experiment has been repeated in Paris and confirmed.

This, therefore, may be considered as conclusive of a muscular electric current circulating in the human body. Those readers who wish to enter more fully into this most interesting subject, can find all the evidence in De la Rive's "Treatise on Electricity;" Vol. III, page 50):—

"We may now regard as demonstrated in a decided manner by the researches of Matteucci and Dubois Reymond—1st. That there exists both in the muscles and in the nerves of all animals, a natural electricity, independent of mechanical, physical, or chemical actions, whether exterior or interior. 2nd. That this electricity is manifested under the form of closed currents circulating along the muscles or the nerves of the animal, and of which we can collect but a very small derived portion by the assistance of our instruments. 3rd. That the presence of this free electricity is subordinate to the state of the life of the animal, and it disappears with the vital force . . . . The laws that govern the electric state of the muscles and nerves are those of their elements."

The illustrious Haller came to the conviction, after many ingenious experiments, that the rapidity of the nervous fluid was at the rate of 9,000 feet a minute. Aldini, a by far more skilled physiologist, on account of his researches in animal electricity, after experimenting, failed to discover its rate. In his second dissertation on animal electricity, read in the Institute of Bologna in the year 1794, he says:—"When this arrangement was made (namely, a conducting medium 150 feer long, the two extremities of this very long arc were applied to

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the armed nerves and muscles of a frog; and the animal electricity, being thus excited, instantly proceeded with so much velocity from the one extremity of the conductor to the other, that no difference could be perceived between the time when the frog touched the conductor and that when it began to be agitated. This circumstance seems to prove, in a striking manner, a great similarity between the nervous fluid and common electricity." It may be imagined that since then the wonderful improvements in mechanism would afford us more accurate ideas of the rate of the nervous current; and this has been the case. An apparatus has been invented by M. Fizeau, to mark extremely minute divisions of time, even to the millionth of a second. By this apparatus, the time required for the centres to reflect the stimulus of the interrupted galvanic current has been computed.

I. Sensations are transmitted to the brain at the rate of 180 per second.

II. The brain takes one-tenth of a second to act upon a muscle by its motor nerve. This of course varies in individuals differently constituted; but it gives one an idea of the time required to produce an effect, after the mind has originated the desire to cause it.

M. Dubois Reymond has also, by a series of most ingenious experiments, demonstrated the course of the electric current of nerve force in the nerves themselves.

In the nerves of sensation and motion the current circulates in the same direction, and upon irritating the nerve it is propagated in all directions equally.

I. The muscular current is not permanent, but is composed of a rapid succession of simple and sudden variations of intensity. It does not recover its intensity immediately, but gradually, after the contractiou has ceased.—(*Dubois Reymond.*)

II. The nerve differs from the muscle in its electric relation in that, when it is traversed in a portion of its length by a continuous current the entire nerve assumes an electric state, which has been termed electrotonic, whence results the production of a current which, according to its direction, increases or diminishes the effect of the ordinary current. The electric phenomena are identical in the nerves of motion and in those of sensation; both of them transmit the irritation in both directions equally.—(*Ibid.*)

III. When a current of electricity is passed through the limb of a living animal, it contracts, and pain is experienced both at the closure of the circuit and upon breaking contact, in whatever direction the current may be passed; but after some time the irritability of the nerves is lessened, so that we find that when the current is direct, the muscles contract when the circuit is closed, and pain is experienced when it is broken. When the current is in the opposite direction—namely, from the periphery to the centre—pain is experienced upon closure of the current, and contraction upon opening it.

IV. Whatever may be the direction of the current when it is intense, all the muscles to which the nerve is distributed, of which one part is traversed by this current, contract at the moment when the circuit is closed, or at the moment when it is opened, and there is at the same time pain. So long as the circuit is closed there is neither contraction nor pain, which is due to the particular state in which the passage of the current places the nerves and muscles. We likewise know that the contractions are more powerful at the opening than at the cessation of the direct current, and that the contrary is the case when the current is inverse, whilst the pain follows the opposite course. The action of the current upon a mixed nerve of an animal recently killed, or living, is remarkable. If a continuous current is caused to circulate in it, excitability is diminished or destroyed when the current is direct; it is preserved and even increased when the current is inverse. If this same nerve has been traversed by the direct current, repose restores to it very promptly a portion of its excitability; if, on the contrary, it has been traversed by the inverse current, it loses by repose a portion of the excitability which the passage of this same inverse current had imparted to it. All these experiments require, in order to their success, feeble and moderate currents—intense currents always diminish the excitabillty of the nerve, and sometimes completely suppress it for a certain time. This diminution or suppression takes place in a higher degree when the current traverses the nerve from the periphery to the centre, than in the opposite direction, which is that of the natural current that takes place in the nerve, at the moment when, under the influence of the brain, this nerve determines the contraction of the muscle to which it abuts.—(*Matteucci.*)

M. Remak thought that he could prove that continuous currents possessed the property of causing contraction to cease, by preserving to the muscles the faculty of obeying the will, and restoring it to them, even in the case in which they might have lost it.

V. When an electric current is passed along a mixed nerve, if it circulates towards the brain, a sensation is experienced; if in the opposite direction, muscular contraction follows; from this it appears that a nerve cannot at the same time transmit the desire of motion to a muscle, and the sense of pain from it.

VI. If a continuous current is made to circulate through a mixed nerve, its excitability is diminished when the current is direct; it is increased when the current is inverse. M. Remak thought that he could allay morbidly excited muscle by the passage of a direct continuous current. M. Matteucci has also recommended continuous currents of electricity for the cure of tetanus.

Now, what is the effect of galvanism upon the circulation? The galvanic current stimulates the heart and arteries to increased muscular contraction, the consequence being an increased flow of blood; it has also the same effect upon the venous system; the tendency to venous congestion, so common, is rapidly removed by the stimulus of electricity. But there are some forms of chronic congestion in which the powerful stimulus of the galvanic current is not suitable, or even convenient; in such the mild continuous current is more adapted; it has the same effect in a slighter degree, but from the convenience of its application it may be much more suitable.

Again, a chronic case requires a more protracted treatment, and a weak continuous current does much more good than a powerful stimulus, used merely for short time. However, I am myself accustomed to make use of both currents—a continous current, constantly passing, the patient wearing one of Pulvermacher's chains, and the induced, interrupted current, with the aid of the apparatus of MM. Legendre et Morin. M. Duchenne asserts that the current of electricity in the induction wire has very different properties from that induced in the secondary coil—the first being always in one uniform diretion, the latter having a to-and-fro direction; the former having more influence upon the muscular system, the latter upon internal organs and the skin. I believe that this latter assertion is not correct; it is true that the induced current has much more penetrative power—resembling, in fact, the electricity generated by an electrical machine, and in that way it has a greater stimulant effect upon deeper organs, simply because it is enabled to reach them; but it also has a greater effect upon the muscular system, in my opinion, and this may be easily understood by referring to observation IV., for being a to-and-fro current the excitability of the nervous system is retained and stimulated instead of being weakened, as would be the case by a current being passed in the same uniform direction.

The rapidity of the intermittences must not be lost sight of. It is important that the currents should follow one another as rapidly as possible, so as to imitate the natural muscular current (obs. I.); they are useful, also, when we wish to excite the sensibility of the skin.

There are two methods of stimulating the muscular and nervous system by electricity—the first is by localising the electricity in a nerve or muscle, by placing the conductors close together so as to localise the current in a nerve, one conductor on the peripheric termination of the nerve, and the other upon a spot in its course, or upon the ganglion, according to circumstances; and in a muscle, one upon its sensitive spot (where the nerve enters), and the other near its insertion. The second method is by reflex action, where the current enters at the periphery of a nerve, passes to its centre and is reflected, and finds its exit at some distant part. This latter requires more care and management, as it might occasionally induce a tetanic state, as I shall presently show.

Feeble to-and-fro currents are suited to those cases in which a long-continued action is necessary, as the excitability of the nerves is retained for a much longer time under its stimulus; they rouse up vitality and exercise a tonic influence over the organic life of parts, principally by stimulating the various muscular tissues to contraction; care, however, is required that the currents are exactly measured to the requirements of the case, otherwise, as Matteucci observes, "an intermittent current excites tetanic convulsions, but sooner exhausts the excitability of the nerves than the continuous current." On the whole, therefore, when passing electricity through any important nervous centre it is advisable to make use of the continuous current.

ON THE FORCES CONCERNED IN PRODUCING MAGNETIC DISTURBANCES.

BY BALFOUR STEWART, ESQ., F.R.S.*

When a bar of steel has been magnetised it has acquired a tendency to assume a definite position with respect to the earth. Nothing is more widely known than this important fact; but, at the same time,

* Read before the Royal Institution of Great Britain, Friday, March 20, 1863, Major General Edward Sabine, R.A., President R.S., D.C.L., Vice-President, in the Chair.

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there is nothing in science more mysterious than its cause. We may endeavour to explain it by asserting that the earth acts as a magnet; but whence it has acquired this magnetism, how it is distributed, and what are the causes of its many changes, are amongst the most perplexing and the most important of those problems in physical science which are yet unsolved.

The force with which the earth acts upon the needle is directive merely; that is to say, the needle is neither attracted nor repelled as a whole, but simply twisted round, and in this respect the earth is similar to a very powerful magnet, the pole of which is placed at a great distance from the needle upon which it acts.

If we keep a magnetic bar constantly suspended in the same place, its position will be subject to many changes. In the first place, there is that change which goes on in the same direction for a great many years together, in virtue of which a needle suspended in this place 200 years ago would have assumed a position very much different from its present one; secondly there is a change of which the period is one year, and this is called the annual variation; thirdly, there is a change of which the period is one day, and which is called the daily variation; fourthly, there is a change which depends upon the moon's hour angle; and, fifthly, the needle is subject to sudden and abrupt changes in position, which are called magnetic storms, and which form the subject of this discourse. During the prevalence of this unaccountable phenomenon the needle is found to oscillate rapidly and capriciously backwards and forwards, being now on the one side and now on the other of its normal or undisturbed position.

It should be here remarked that the physicist regards the needle merely as a vane (similar to a wind-vane) which serves to render visible the direction and intensity of that mysterious force which operates through the earth. It is really the earth's magnetism with which he concerns himself.

Gauss, who has done so much to further the science of magnetism, showed, by means of a preconcerted system of observation, that magnetic storms affected the needle at Göttingen and at other stations in Europe at precisely the same moment of absolute time; and after the establishment of the colonial observatories, it was found by General Sabine that the needle was affected in Toronto at precisely the moment when it was disturbed at Göttingen. Nor is it too much to say—with our present knowledge, that these remarkable distu[illegible] out at the same moment over every portion of our globe.

Having thus shown that these phenomena are cosmical in their character, the next point of interest is their connection with the sun. This has been placed beyond doubt chiefly through the labours of General Sabine, who found at Toronto and elsewhere that magnetic disturbances obey a law of hours. Mr. Broun also showed the same thing from his observation of the needle at Makerstoun, in Scotland. It may be instructive to point how this proof was deduced from the colonial observations; and to make the matter plain let us refer to an imaginary case in the familiar science of meteorology. Suppose that while an observer is watching his thermometer there is a sudden influx of cold weather, and that it is wished to estimate the influence of this upon the thermometer in a given day and at a given hour of that day, what must the observer do? He must endeavour to ascertain, by the best possible means, what indication the thermometer would have afforded at that specified day and hour had there been no cold weather. Comparing this with the actual height of the mercury, and deducting the one from the other, he would clearly obtain a measure of the effect of the cold weather upon the thermometer.

A similar course was pursued by General Sabine in discussing the colonial magnetic observations, with the object of deducing the laws of disturbances. It was first necessary to ascertain, by the best possible means, what position the magnet would have assumed at any particular day and hour, had there been no disturbance. Calling this the normal value, the next course was to group together as disturbed all those positions of the magnet which differed from the normal by more than a certain small quantity. The necessity for this separation will become evident when it is remarked that the disturbed and the regular observations have different hourly turning-points, and obey very different laws. Thus a disentanglement was effected, which was accomplished by the employment of a separating value. The selection of this value is to some extent arbitrary, but it was shown by reference to a diagram that the disturbance law at Kew was virtually the same, whether this were deduced (in the case of the declination) from ninety-five days of principal disturbances or from all disturbed observations which differ from the normal by more than 3'·3. It was also shown from the same diagram that easterly disturbances prevail at Kew during certain hours of the day, and westerly disturbances at certain other hours, thus exhibiting a daily law, and showing that disturbances are therefore connected with our luminary.

There is, however, a more interesting and mysterious connection than this. Professor Schwabe, of Dessau, has now for nearly forty years been watching the disc of the sun, and recording the groups of spots which have been visible, and he finds that these have a period of maximum nearly every ten years, two of these periods being the years 1848, 1859. Now it was likewise found by General Sabine, that the aggregate value of magnetic disturbances at Toronto attained a maximum in 1848, nor was he slow to remark that this was also Schwabe's period of maximum sun-spots, and it was afterwards found, by observations made at Kew, that 1859 (another of Schwabe's years) was also a year of maximum magnetic disturbance. This fact is eminently suggestive, and brings us at once into the presence of some great cosmical bond, different from gravitation, adding at the same time additional interest as well as mystery to these perplexing phenomena.

These are the grounds on which we suspect the sun to be the agent which causes magnetic disturbances, but there is also some reason to believe that on one occasion our luminary was caught in the very act. On the 1st of September, 1859, two astronomers, Messrs. Carrington and Hodgson, were independently observing the sun's disc, which exhibited at that time a very large spot, when about a quarter past eleven they noticed a very bright star of light suddenly break out over the spot and move with great velocity across the sun's surface.

On Mr. Carrington sending afterwards to Kew Observatory, at which place the position of the magnet is recorded continuously by photography, it was found that a magnetic disturbance had broken out at the very moment when this singular appearance had been observed.

The next point to be noticed is, that magnetic storms are always accompanied by auroræ and by earth currents. With regard to the latter of these phenomena, a single word of explanation may be necessary. Earth currents are currents of electricity which traverse the surface of our globe, a portion of which is caught up by the telegraphic wires, which are often thereby seriously disturbed in their communications. A table was then referred to, which showed that auroræ and earth currents have the same ten-yearly period as sun spots and magnetic disturbances, so that a bond of union exists between those four phenomena.

The question next arises, what is the nature of this bond? Now, with respect to that which connects sun-spots with magnetic disturbances we can as yet form no conjecture; but we may, perhaps, venture an opinion regarding the nature of that which connects together magnetic disturbances, auroræ, and earth currents. And here we may remark that this latter bond is the more definitely determined of the two, since the three phenomena which it embraces invariably occur together.

In order to exhibit the evidence upon which this hypothesis rests, it is necessary to refer to what is done at the Kew Observatory.

By means of an apparatus arranged by the late Mr. Welsh, the values of the components of the earth's magnetism are there recorded continuously by photography. Now there is a proposition which goes by the name of the parallelopiped of forces, and which asserts that if three forces acting at a point be represented in magnitude, and in direction by the three sides of parallelopiped, the resultant of these forces shall be represented in magnitude and direction by the diagonal of the parallelopiped. These three forces may be said to be components of the whole resultant force, since the joint action of the three is the same as that of the resultant.

To refer to a familiar case, suppose that there is a gust of wind which (as sometimes happens) is not horizontal, but blows downwards in a slanting direction from above. How shall we estimate the direction and the force of this wind? Let us have three pressure plates, one north and south, one east and west, and one up and down; then the north and south component of the wind will be given by the first, the east and west component by the second, and the up and down component by the third, and exhibiting the indications of these three pressure plates by the three sides of a parallelopiped, the diagonal will represent the wind in magnitude and direction.

Something of this kind must be done, if it be wished to record the disturbing force which acts upon the needle. Let there be three magnets free to move, two in a horizontal plane and one in a vertical direction; one swinging freely and pointing to magnetic north and south, one compelled by torsion to point to magnetic east and west, and a third balanced on a knife-edge so as to move up and down; the first will be sensitive to an east and west disturbing force, which will act at right angles to it, and tend to twist it round; the second will on the other hand be affected by a north and south force, and the

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third by a vertical force. It is easily seen how these three magnets will take the place of the three pressure plates in the meteorological problem. Now, if a mirror be attached to each of these magnets, it may be made to reflect the image of a dot of light upon a sheet of photographic paper, so that a small motion of the mirror shall cause a large motion of the dot, and if the paper itself move by clockwork, in a direction at right angles to that in which the dot moves on the paper, the photographic impression of the dot during a day's motion of the paper will be a curved line, and this being obtained for each of the three magnets, we shall be able to record continuously the changes which are taking place in the three components of the earth's magnetic force.

(*To be continued.*)

LAWS OF MAGNETIC FORCE.

This subject has occupied the attention of many of the most profound mathematicians. Newton inferred "from some rude observations" that the power of a magnet decreases not in the *duplicate* but almost in the *triplicate* ratio of the distance. Hawksbee's experiments (*Phil. Trans.* 1712, vol. xxvii.) gave a law of force which varies as the *sesquiduplicate* ratio of the distances, and his results were subsequently confirmed by Whiston and Taylor (*Phil. Trans.* 1721). Muschenbroek's researches, made a few years later, led him to the conclusion "that no assignable proportion exists between the forces and the distances, whether of attraction or repulsion." Mayer and Martin, who wrote on the subject between the years 1750 and 1760, both came to the conclusion that the true law of the magnetic force is identical with that of gravitation, and that in the previous experiments of Hawksbee and others, proper allowance had not been made for the disturbing changes in the magnetic forces so inseparable from the nature of the experiments. Lambert's researches* (*Historie de l'Academie Royale des Sciences, Berlin*, 1776), which were described by Dr. Robinson as worthy of Newton himself, determined that the action of magnetism on a magnetic needle, considered as a lever, is proportional to the lines of the angle of obliquity of its direction; and that hence the effective force which operates in restoring the needle to its meridian when drawn aside from it, is directly as the line of the angle of its deflection. The law of force was found to be the inverse duplicate ratio of the distances. The directive or polar force of a magnet upon a small needle, was shown by Lambert in a subsequent memoir to be "as the absolute force or magnetic intensity of the particles directly, and as the squares of the distances inversely." Lambert's deductions were confirmed twenty years later by Coulomb, by means of his torsion balance, and more recently (about the year 1817), by Professor Hansteen, of Christiania.

Amongst the latest inquiries are those of Sir W. Snow Harris. (*Edinb. Phil. Trans.*, 1829; *and Rudimentary Magnetism*, Part III.) He first investigates the laws and operation of the elementary forces of induction—the essential function of all magnetic development. When a bar of soft iron and a magnetic bar are opposed to each other, the near pole of the latter induces on the near parts of the former, a polarity the reverse of its own, and a polarity of a similar nature on parts at a distance. The temporary polarity of the iron reacts on the magnet by a kind of reflection or reverberation, inducing on it a new temporary polarity of the same character as its own permanent one; this new force again reacts on the iron, and thus a series of magnetic waves is produced, each becoming weaker until they vanish into rest. Magnetic attractions and repulsions being the results of this inductive reverberation, the study of the laws of the elementary force of induction became necessary as a preliminary to the investigation of the laws of the magnetic force generally.—*From Noad's Manual of Electricity.*

Colonial Telegraphy.

SOUTH AUSTRALIA.

REPORT BY SUPERINTENDENT OF TELEGRAPHS ON THE PROPOSED ANGLO-AUSTRALIAN AND CHINA TELEGRAPH SCHEME.

Observatory and Telegraph Department, Chief Office, Adelaide, October 8th, 1862.

Sir,—I have read the prospectus issued by the promoters of the Anglo-Australian and China Telegraph, which you were good enough to refer to me; and agreeably with your request, I have now the honour to offer a few brief remarks on the project, as presented in that document.

The advantages to be derived by the Australian Colonies generally, from having telegraphic communication with India, China, and Europe, are too obvious to require comment; and any well digested scheme, such as that now before me, for carrying so vast a work to a successful consummation, requires the prompt and earnest consideration of the several Colonial Governments interested. So far as the promoters' plans are made known they seem to be well matured, and calculated to attain their objects—and warrant my recommending their proposals to the Government as the basis of further negociation.

When Mr. Gisborne visited Australia, in 1859, he proposed to lay a cable similar, but slightly heavier than the one then just laid in the Red Sea, from Banjoewangi (E. Java), to Moreton Bay, in five sections, viz.:—

Banjoewangi to Coepang	590 knots
Coepang to Port Essington	525 „
Port Essington to Cape York	635 „
Cape York to Cape Cleveland	619 „
Cape Cleveland to Moreton	655 „
Total	3,024 „
Twenty-five per cent. slack cable	756 „
Total length of cable	3,780 knots.

The total capital required to carry out the undertaking, including the building of six stations, staff of electricians employed, instruments, &c., was estimated at £800,000.

In a letter addressed to Sir R. G. MacDonnell, C.B., the late Governor-in-Chief, dated Kangaroo Island, July 4, 1859, Mr. Gisborne offered, on the part of the promoters, to complete the line within two years; and proposed that, when completed and in working order, it should either be held and worked by the several Colonial Governments or by a private company; in which latter case he would require for such company a guarantee of six (6) per cent. on the capital paid up from time to time while the work was in progress; and on its completion, such sum as might be required to supplement the net receipts up to six (6) per cent. on the actual outlay; the [illegible] to be apportioned among the colonies, taking their respective [illegible] wards the moiety of the postal subsidy as a preliminary [illegible] ating the amounts to be paid by each, or as follows:—

Victoria	58 5/16
New South Wales	22 13/16
South Australia	7 1/16
New Zealand	5 1/16
Tasmania	5 1/16
Western Australia	1/16

At the date of Mr. Gisborne's visit, the Red Sea cable had just been laid to Aden, and was continued to Kurrachee at the end of the same year. From Kurrachee the Indian lines extended to Rangoon, on the eastern side of the Bay of Bengal: so that had the cable between Suez and Kurrachee continued in good working order, there would have been an uninterrupted line of communication from Alexandria to Rangoon—the only break with England being between Alexandria and Malta or Trieste. The Indian Government engaged to continue the line to Singapore simultaneous with the extension to Australia; and the Netherlands Government granted concessions to Mr. Gisborne, enabling him to land his cable at E. Java, and affording every facility for the use of the land lines in that island, and the cable (then ordered) to Singapore.

Since then, however, the Red Sea and India cable has turned out an almost complete failure; a portion only, as far as Jubal, having been made workable. A new cable has, therefore, been decided on. This will be three and a half times heavier than the old one. The core will consist of seven strands of copper wire, forming one conductor, insulated with three coatings of gutta percha, and three of Chatterton's compound, laid on alternately, covered with a thick serving of tarred hemp and jute, and encased by ten No. 6 w.g. best charcoal wire, protected from corrosion by a thick hard bituminous coating, according to Latimer Clark's process, and hydraulic mortar. The promoters propose to lay a precisely similar cable to Australia. By the September mail I received a sample of it, and feel very confident of its working well, if perfect when laid.

The result of Mr. Gisborne's former negociation was a subsidy from New South Wales, amounting to £9,625, and from Victoria, £13,000, for a term not exceeding twenty-one years.

The following resolutions were passed by the Legislative Assembly of New South Wales:—

* For a full discussion of these profound researches, the reader is referred to Sir Wm. Snow Harris's Rudimentary Magnetism, Part III.

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RESOLUTIONS SUBSIDIZING SUBMARINE TELEGRAPH TO JAVA PASSED BY THE LEGISLATIVE ASSEMBLY OF NEW SOUTH WALES, FEBRUARY 2ND, 1860.

7. Telegraphic communication with the United Kingdom :—On the order of the day being read, the speaker left the chair, and the house resolved itself into committee of the whole, further to consider of an address to His Excellency the Governor-General, with reference to a subsidy towards telegraphic communication with the United Kingdom.

The chairman reported that the following resolution had been agreed to in the committee,

Resolved—That an address be presented to His Excellency the Governor-General, embodying the following resolutions :—

1. That this house is of opinion that the Government of this Colony should be authorized to grant a subsidy not exceeding £9,625 per annum for a term not exceeding twenty-one years, to any company, of the stability of which satisfactory assurance shall be given, to induce such company to construct and maintain a telegraph line from this Colony to East Java, upon the following conditions, that is to say :—

(1.) That the Government of Victoria shall make arrangements with such company, by subsidy or otherwise, for the residue over and above the annual subsidy of this Colony, necessary for the carrying out of the work.

(2.) That the period within which the first call of the subscribed capital of the company shall be made shall be limited to twelve calendar months from the date of the concurrence of the Colony of Victoria in the preceding condition.

(3.) That the whole work shall be completed and in effective operation within three years from the present date, subject, however, to such extension of time to meet possible contingencies as may hereafter be agreed upon.

(4.) That the proposed subsidy shall be proportionally payable on the capital of the company as paid up.

(5.) That the payment of the said subsidy shall be conditional on the maintenance of the line in effective working order, and that no payment shall be made until the line is completed.

(6.) That no tariff of charges shall be established without the concurrence of [illegible]any.

(7.) [illegible]s event of the net profits of the company exceeding in any ye[illegible]te of ten per cent. per annum, such excess shall be rateably [illegible]ied to reduce the respective contributions of this Colony and of Victoria.

2. That steps be taken without delay to communicate with and settle the proportionate contributions of the other Colonies in aid of the respective contributions of New South Wales and Victoria.

The foregoing resolutions were based on the assumption that the total amount of the subsidy would not exceed £35,000 of which New South Wales, assisted by Queensland, was to pay 27½ per cent. or £9,625 ; and the second resolution required that the Victorian Government should hold themselves responsible for the residue, the other Colonies, South Australia and Tasmania, contributing to the Victorian subsidy in equitable proportions.

On the 23rd of May, 1860, the following resolutions were passed by the Victorian House of Assembly :—

RESOLUTIONS SUBSIDIZING SUBMARINE TELEGRAPH TO INDIA AND EUROPE, PASSED BY THE LEGISLATIVE ASSEMBLY, VICTORIA, MAY 23RD, 1860.

6. Telegraphic communication with India and Europe.—Mr. Lalor reported from a committee of the whole certain resolutions, which were read, and are as follows :—

Resolved—II. That the Government of this Colony be authorized to grant, in conjunction with the Imperial Government, and with all or any of the Australian Colonies, an annual subsidy, not exceeding in the whole £35,000, for a term not exceeding twenty-one years, to any company of whose stability satisfactory assurance shall be given, to induce such company to construct and maintain a line of telegraph which shall connect this Colony with any portion of the Indian and European telegraph lines at present in working, or that may hereafter be constructed, upon the following conditions :—

(1.) That such company shall within two years after a contract has been entered into, construct such line of telegraph, unless prevented by war, or the dangers or accidents of the seas, and afterwards maintain it in working order at his own expense.

(2.) That the proposed subsidy shall be proportionably payable on the capital of the company actually paid up and expended, and shall not exceed five per cent. on such capital ; and the contract for the manufacture and laying of the cable shall be open to public tender and the lowest tender accepted—the satisfactory nature of which competent electricians in England shall determine.

(3.) That no payment of such subsidy shall be made, until the line of telegraph to be constructed has been in working order for three consecutive months ; and such payments shall be made rateably only for the period during which the line so constructed is open for the transmission of messages.

(4.) If such line shall be closed, unless by reason of war, or shall not be in a state of efficiency for the trsnsmission of messages for any eighteen consecutive months, then the contract with such company shall be void.

(5.) That a tariff of charges for the transmission of messages over such line shall be agreed to by the several contracting Governments and the company, before any contract is entered into ; and such tariff shall not afterwards be altered without the concurrence of such Governments.

(6.) That in the event of the net profits of the company exceeding in any year the rate of ten per cent. per annum, inclusive of the subsidy, such excess shall be rateably applied to reduce the respective contributions of the contracting Governments.

III. That the proportion of the entire annual subsidy to be granted, as the contribution of this Colony, shall not exceed the sum of £13,000 in any one year.

IV. That in any agreement which may be entered into with any other Colony, for the purpose of making up the amount of subsidy required, it shall be an express stipulation that the actual annual payments of such Colony and of this Colony shall be in proportion to the value of the messages transmitted by each along the line in every year.

V. That upon the completion of the preliminary arrangements for a contract, in terms of the foregoing resolutions, a Bill be brought in for the purpose of authorizing the annual expenditure required.

VI. That these resolutions shall be in force only for two years, and shall be forthwith published in the United Kingdom.

These resolutions limited the amount of the Victorian subsidy to £13,000, which with the £9,625 from New South Wales left £12,375 to be contributed jointly by the Imperial Government and the other Colonies, or failing assistance from the former, by the latter alone.

The fourth resolution, providing for the subsidy, being apportioned according to the number, and value of the messages transmitted, appears to be the most equitable arrangement.

I may further state that from all of the colonies Mr. Gisborne received assurances of co-operation, though on the part of South Australia a strong feeling existed in favour of a land line to some point on the north coast, partly because of the increased facilities such a line would afford for the opening up and settlement of the interior ; and partly because, if traversing practicable country, of the diminished outlay required for its construction.

For further information I beg to refer you to my report on Mr. Gisborne's scheme (Parliamentary Paper, No. 127, 1859), and also to my last Annual Report (Parliamentary Paper, No. 25, 1862), where I have entered very fully into the comparative merits and costs of the several routes which have at various times been suggested.

I now come to the prospectus recently received. The objects of the promoters are—

1. To lay a submarine cable to connect Singapore with the telegraph system of India, at Rangoon, the present terminus of that system, over a distance of 1,090 sea miles, with intermediate stations at Amherst (Moulmein), King Island, and Penang.

2. To extend the cable from Singapore to Hongkong (Canton), *viâ* Sarawak, Labuan, and Manilla, a distance of 2,080 miles, or *viâ* the French settlement of Saigon, a distance of 1,678 miles.

3. To extend the Dutch lines which connect Singapore with Batavia and the east end of Java, from that point to the terminus of the telegraph system of Australia, which at present is at Brisbane, on the eastern coast, but which is likely to be soon carried further northward.

The third will be the Australian section. From Java to Brisbane, *viâ* Timor, is 3,024 miles.

So far as is known from soundings already made, the different cables would lie on a soft and uniform sea bottom not exceeding fifty fathoms in depth. The sections would be in good working length—over which from fifteen to twenty words per minute could be easily transmitted.

As before explained, it is intended to lay a very superior cable to the one originally proposed, weighing 74 cwt. to the mile. This increases the cost from £800,000 to £1,100,000.

The relative cost of the three sections is estimated as follows :—

Rangoon to Singapore	£450,000
Singapore to Hongkong	530.000
Java to Brisbane	1,100,000
Total	£2,080,000

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With regard to the first portion, the promoters have received an assurance of the work being either assisted or carried out by the Indian Government contemporaneously with the other sections.

To carry out the third division the promoters now apply to the Australian Governments for a guaranteed subsidy of £50,000 per annum for thirty years, "on the basis already adopted in the resolution passed by the Legislatures of New South Wales and Victoria in 1862;" except, that instead of all profits in excess of 10 per cent. being appropriated towards the reduction of the subsidy, it is now stipulated, "that in the event of the net profits of the company exceeding in any year the rate of *fifteen* per cent. per annum, whether derived from subsidy or other sources, such excess shall be rateably applied to reduce the respective contributions of the contracting Governments."

The reason for this is the difficulty in inducing capitalists to embark in enterprises of this sort, where so much risk is incurred, without the prospect of large profits being held out.

They offer, however, in return, to transmit all messages on the service of the Colonial and Home Governments *free* to the extent of the subsidy; or, should the latter not contribute, the charge made on their messages is to go to the credit of the subsidy payable by the colonies. This I think is very liberal.

Should the Queensland lines be extended to Broad Sound—which is most probable—the cable would, of course, terminate there.

In a letter addressed to myself—a copy of which accompanies this report—Mr. Gisborne says the promoters would be prepared to meet the Australian lines at whatever point they might be brought to, provided they could be completed by the end of 1864. He expresses his doubts as to the practicability, or expediency, if practicable, of having long land lines traversing an unsettled country with a hostile or mischievous native population; and he urges the difficulty of maintaining such a line in working order, when completed. There is, of course, considerable force in the objections raised by Mr. Gisborne; but I must confess that, in my opinion, the way for a land line seems clearer now than it did even two years ago. The comparative ease with which Burke, Landsborough, and McKinlay have separately crossed to and from Carpentaria, and the encouraging descriptions given by those explorers of the country, all indicate the speedy occupation of the territory between Cooper's Creek and Carpentaria; and in South Australia we have already stations within a short distance of the former.

A land line offers so many collateral advantages, besides its diminished cost, that I cannot forbear urging the desirableness, before pledging ourselves to Mr. Gisborne's scheme in its entirety, of immediate steps being taken to determine the feasibility of carrying the wire to the north coast.

The construction of a land line would appear to rest with South Australia or Queensland, according to the route selected. We have now a choice of four, viz.:—

1st. Port Augusta, by Stuart's route, to the Victoria River, Cambridge Gulf.

2nd. Port Augusta, *viâ* Cooper's Creek, to Carpentaria, by Burke's, or McKinlay's route, and thence to Port Essington, or Cambridge Gulf.

3rd. Port Augusta to King George's Sound and Western Australia, to the neighbourhood of Exmouth Bay.

4th. Moreton Bay to Port Essington, or Cambridge Gulf.

With the first, second, and fourth, the submarine line would be the same; with the third, it would have to be in one length to Java.

The cost of the land section would vary from £150,000 to £185,000; and the submarine, taking the distance from the north coast to Cape Sedano, E. Java, at 940 knots and allowing 60 knots of slack, or 1,000 knots of cable at £240, including laying, and using the same kind of main cable as that proposed, weighing 74 cwt. to the knot, with two shore ends of 50 knots each, weighing 154 cwt. to the knot—£240,000. The total cost, therefore, of a line by either of the first, second, or fourth routes, may be approximately estimated at £425,000. This would be exclusive of stations on the north coast, Coepang, and Cape Sedano.

On the overland line it would be necessary to have stations every hundred miles or so—say twelve stations in all. At each station beyond the settled districts there should be a staff of four persons—one electrician, and three line men. I have before expressed an opinion that, by attaching a run to each station, persons properly qualified might be induced to undertake the very light duties of the office at a reasonable rate of remuneration; and such a course would afford profitable employment to the assistants, or line men. Failing that, however, I should estimate the cost of maintenance of the land section as follows:—

Twelve stations, salaries, and maintenance ...	£12,000
Contingent expenditure	5,000
Renewal fund	3,000
Total annual maintenance	£20,000

With regard to the submarine cable from the north coast to Java, I do not think it would be necessary to keep a steamer constantly in readiness to effect repairs. If the cable continued perfect, little or no expense would be incurred; but, on the other hand, any casualty occurring might involve a very large expenditure—I do not think that very probable, however. There would be three stations, with three officers at each. We may set down the annual cost of the stations, with maintenance, &c., at £5,000—to this should be added a renewal fund (nearly proportionate with that provided by the promoters of the Java-Brisbane scheme, viz., £12,000) of £3,000, making the total annual cost of maintenance of a line from Port Augusta to Java £28,000.

Mr. Gisborne's first estimate of the annual cost of maintenance of a line from Java to Brisbane was £18,283 7s. 6d. It is now increased to £50,500, including, however, a renewal fund of £12,000, to be set apart annually.

It should be borne in mind that both of the foregoing estimates are but preliminary and rough approximations—they are both, in my opinion, considerably in excess of what the actual expenditure would be. I have very largely increased my estimate of the annual cost of the land line; but, at first, extra precautions would have to be taken to secure the integrity of the line, and I do not wish to prejudice the public mind by under-estimating the cost of that route, and over-estimating that advocated by Mr. Gisborne. I wish to see the work commenced and successfully completed, and that plan adopted which, after due consideration, shall be thought best calculated to secure the object we mutually seek to accomplish.

If the land line is erected by South Australia or Queensland, I would suggest that each colony should subsidise it, or supplement the net receipts, so as to provide six per cent. interest on the outlay; the contributions being apportioned according to the number of messages.

With regard to the cost of messages, and the probable revenue, I am of opinion that the total through charge for a message of twenty words (including name and address) should not exceed £6 or £7. The rate at present from Jubal, in the Red Sea, to London, is £3 5s. for twenty words. The Indian tariff to all stations from Kurrachee to Rangoon, a distance of 2,700 miles, is 4s. The Red Sea and Mediterranean charges are at present very high, but may be regarded as more local than through rates. The increase of business which the completion of the India and Australian lines would bring, would no doubt enable the several companies to effect considerable reductions. In Mr. Gisborne's letter to His Excellency the Governor-in-Chief (July 15, 1862), the charge on the first opening of the line is limited to 2s. 6d. for every 100 miles; that, however, would be an exorbitant rate. It was formerly suggested that 30s. should be charged on the Java-Australian section, and that I think would be reasonable. In the prospectus, the number of messages is estimated at 40,000—based on the amount of shipping and the number of mercantile firms in the Australian trade. Suppose we say 30,000 messages; that would produce a revenue of £45,000, and leave a profit of £17,000 in the one case, and about covering the working cost in the other.

In a work of such magnitude, nothing can be done without the action of the Colonies concerned; and as the best means of securing this, I would recommend that a conference should be held between the heads of the Telegraph Departments in Victoria, New South Wales, Queensland, and South Australia; who, being practically acquainted with all the details, would be best able to consider the whole question, and give the results of their meeting in a joint report to their respective Governments.—I have the honour, &c.,

Charles Todd,
Observer and Superintendent of Telegraphs, S.A.

The Hon. the Commissioner of Public Works.

Letter from Mr. Gisborne to Superintendent of Telegraphs, South Australia.

"Dear Sir,—I have written by this mail to the several Australian Governments, asking them to apply the subsidies, that were either voted or promised in 1860, to carrying out at once the Java-Queensland line of telegraph. I send you a box containing samples of the proposed cable; and in the box are contained parcels which I will ask you to be kind enough to have delivered to their address; the documents you will receive will very fully explain the objects of the promoters, and their plan for carrying them out. They propose to carry out a complete telegraphic system between India and China, and India

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and Australia, including a new cable between Singapore and Batavia. The estimates I have communicated to Sir Dominick Daly will inform you that we propose to lay a cable about three and a half times as heavy as that I proposed in 1860—the difference in weight being made by the extra thickness of iron wire outside the core. We also propose to cover the iron wires with a coating of jute, bitumen, and hydraulic mortar, to prevent the injurious effects of corrosion and chemical action, which are the great enemies to the outer covering of submarine cables, and not friction, as was at first supposed, and even now is not uncommonly believed. You will also receive statistics about submarine cables, which show conclusively that shallow sea lines, laid within 100 fathoms, have been almost uniformly successful—the few that have failed, have failed because the route was improperly chosen. The outlay for the cable now proposed will be £1,000,000, the capital being £1,000,000; the fund for repairs and renewal includes £100,000 reserved, £12,000 laid by every year, and 317 miles of square cable at the least; this, at the end of fifteen years, will represent a total fund of £450,000. The £12,000 laid by every year will, at four per cent. compound interest, amount to over £240,000: and the cable may be taken at £300 per nautical mile. However, I have not the smallest doubt that you will be perfectly satisfied with the arrangement made by the promoters successfully to carry out their work; the point which you will dispute will be the propriety of having Brisbane or Broad Sound as the terminus of the cable in Australia. I have lately conversed with Sir Richard MacDonnell upon this subject, and have no desire to adopt any other terminus than Cambridge Gulf, if South Australia will extend its telegraphic system to that point by the end of 1864, when we shall be prepared to lay our cable, if the assistance we ask for is granted. I must, at the same time, state that I do not believe, for obvious reasons, that any of the other colonies will assist South Australia in carrying out such a work, nor do I believe it to be practicable to carry it out within that time; I might add, if necessary, that I do not believe that such a line of telegraph will be maintained in permanent working order, until the white population becomes considerable and continuous throughout the intervening country. The greatest difficulty is experienced even in Europe in maintaining telegraph lines free from interruptions wherever they leave the railway or high road. However, the promoters will adopt Cambridge Gulf as the terminus for their cable, if the land lines are extended to that point by 1864, and sufficient security is given in the meanwhile that they will be so; they have no sort of interest in any one terminus for their cable over any other. I can say no more upon this subject, and will beg you and all those who desire to see telegraphic communication established with England to do that which is directly calculated to effect the principal object in view. The establishment of telegraphic communication between India and Australia will bring Australia within sixteen days of England, and convert the present monthly into a weekly communication. The repairs of the Red Sea and India telegraph have failed, and a new cable will have to be laid; but that will probably be done by the time the Java-Queensland line is completed, though the advantages I have mentioned are quite independent of the restoration of that line.

I remain, &c.,

F. Gisborne.

SUBMARINE TELEGRAPH COMPANY.

The report which appeared in last week's *Electrician* of the meeting of this Company, held on the 21st ult., contains several errors and omissions, which, from special information received from officers of the Company, we are enabled this week to correct. The following is the amended report:—

On the 21st ult., an extraordinary meeting of the shareholders of this Company was held at the London Tavern, Sir James Carmichael in the chair. The Chairman said they were aware that they had been called together for the purpose of taking their opinion upon two questions. The first was that of declaring a dividend, and the second for the purpose of raising more capital. The Directors had recommended a dividend because it had been earned, but it was for them to decide whether they would take it or strengthen the hands of the Directors by leaving that money to be invested. Sir Charles Bright said there was a great deal of depreciation going on in the Company's lines, and that provision ought to be made for it. There was no reserve fund whatever to provide for renewals; they were not like a young company starting with new lines, (although even then common prudence would dictate the commencement of a sufficient reserve fund), they had been at work for twelve years, and before very long would have to replace the older parts of their line. As long ago as 1859, when Mr. Glass and Mr. Canning (who had been repairing and examining the Calais cable), were examined before the Government Committee, they gave a very bad account of the condition of the line. During the first six years of the Company's existence no expense was incurred for repairing cables; they had since deteriorated, and during the last six years the charge for repairs amounted to more than £24,000. This would increase as the cables became weaker, and were consequently more liable to injury from anchors, until at last it would be cheaper to take them up and lay new ones, than incur the large annual expense of repairs. This would not be the case, except on the oldest lines, for some time; but it was necessary to exercise some foresight, and to prepare beforehand, else the Company might be suddenly placed in a very awkward position at some future period. He had urged the prudent course of forming an adequate reserve fund by degrees on several occasions, although he was aware that this suggestion would involve some self-denial and sacrifice on the part of the shareholders, and might not, in consequence, be very popular. He was opposed to the declaration of any dividend, especially as a large amount of debt was outstanding, which must be paid off without delay. It was in his judgment not only unbusinesslike, but deluding themselves, to attempt to form a reserve fund (which should come from revenue) out of capital. He recommended the entire balance from the last half year being made the nucleus of a reserve fund.

Alderman Dakin thought they ought to be guided by the Directors in their deliberate opinion as to the advisability of taking the dividend.

Mr. France, the engineer of the Company, said it was quite true about the depreciation. There was a line round the coast extending some eight or nine miles out, which was of hard chalk. In the Straits of Dover the cables got the most wear, but further out there was a sand bottom, and the cables being embedded in sand were more protected. The Calais line had only been broken once in twelve years beyond this boundary, and the Ostend cable had never been disturbed beyond the Sandettie banks, some eighteen or nineteen miles. The iron undoubtedly depreciated, the depreciation being less under the sand than on the hard chalky bottom. Gutta percha was subject to no depreciation under water.

Some discussion having taken place, the Chairman said that after the issue of additional stock and getting rid of the present loan to the bankers, they would be able to pay the same dividend on the old and the new stock as they were now paying, and they would be free and out of debt altogether. He then proposed a resolution authorizing the issue of the new capital. The motion was seconded and carried almost unanimously. A resolution for the payment of a dividend, as recommended at the last meeting, was then agreed to; and after a vote of thanks to the Chairman, the meeting separated.

TELEGRAPH SHARES.—*Thursday's Quoattions.*

Shares.	Companies.	Paid.	Closing Prices.	Business done.
Stock	British and Irish Magnetic Tel.	100	65 to 69	———
Stock	Electric Telegraph . .	100	100 to 102	———
5	London District Telegraph .	all	2 to 2½	———
10	Mediterranean Extension Tel.	all	3 to 4	———
1	Submarine Telegraph, scrip. .	all	⅜ to ⅝	———
2	Telegraph to India (limited) .	1	¼ to ⅝ dis.	———
5	United Kingdom Telegraph .	3	par to ½ pm.	———

PRICES CURRENT OF INSULATING MATERIALS.

India Rubber.

Para First Quality	1s. 11d. to 2s.	per lb.
Second „	1s 7d. to 1s. 9d.	„
Third Negro	1s. 1d. to 1s. 2d.	„
Java	1s. 5d. to 1s. 6d.	„

Gutta Percha.

Fine	2s. 6d.	per lb.
Genuine mixed	1s. 9d. to 2s. 2d.	„
Reboiled good	1s. 5d. to 1s. 9d.	„
Ordinary ditto	9d. to 1s. 0d.	„

April 29, 1863.

Wm. Kirkmann,

4, *Howford Buildings, Fenchurch Street, E.C.*

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Correspondence.

[We are not answerable for the opinions and statements of our Correspondents.]

EUPHRATES VALLEY AND PERSIAN GULF TELEGRAPH LINE.

To the Editor of The Electrician.

Sir,—The objections to the Euphrates Valley and Persian Gulf line are not to be sought for in the formation of the countries it has to traverse, but in the disposition of their inhabitants.

I have heard that Sir H. Rawlinson has endeavoured to maintain the contrary, but few other persons who have lived long in Turkish Arabia will endorse Sir Henry's doctrine.

The fact is, that the line *must* pass through a great extent of country entirely in the hands of the Enayzeh and other predatory Arab tribes who never have obeyed the Sultan's authority otherwise than temporarily, and who, like most Asiatics will certainly look with superstition and Mahomedan prejudice on the establishment of a line which will infallibly be considered by them merely a prelude to the introduction of European rule.

The operators and wires *may be* preserved by the increasing payment of black mail, but even the success of this method cannot be depended on for any length of time, and the Sultan will not be able to punish offenders who are constantly on the move.

I do not gather from the article in the Electrician reporting Mr. Todd's paper, whether or not the cable is to be carried from Bussora along the Persian Gulf, and then round by sea to Kurrachee, which would, I think, be the safest and cheapest mode, or from Bussora to Bushire or Bunder Abbas in Persia by sea, and thence by land to India.

Should the land line be adopted, the difficulties before mentioned as likely to arise in Turkish Arabia would still more probably present themselves in Mekran and Beloochistan, in the greater portion of which provinces there is not even a semblance of government, and where the same fanatical prejudices prevail.

In some portions of the vast and sparsely populated Turkish empire, in Asia Minor, in Syria and Armenia, and in the neighbourhood of the great cities, protection might be given to a telegraph line and to the operators with comparative ease, owing to the vicinity of troops, but in the wild districts frequented by the Enayzeh it would be necessary to establish a regular system of military posts in the style of the Russians in the Caucasus, at an expense which Turkish finances would have some difficulty in meeting, even with the aid of European capital.

Constant patrolling would be necessary between the posts, for even the continual payment of black mail would not, as I said before, remove from the Arab mind the impression that the end of the undertaking would be the annihilation of their wild freedom and of the rights which they have inherited from their ancestors.

In Beloochistan the same precautions would be needful, and would, in all likelihood, end in a general revolt.

Without an entire army the line could not be held.

An Indian Officer who has passed Eighteen Years in various Eastern Countries.

THE VOLTAIC BATTERY.

To the Editor of The Electrician.

Sir,—Last week I was fortunate enough to see your journal, when I at once became a subscriber. I had forwarded to me last night your impressions for 10th and 17th inst. On perusing them I find that some of your correspondents are experimenting with a view to increase the effective power and lessen the inconveniences attending the working of a voltaic battery. I have been engaged myself upon the same subject for some time, and am engaged at present testing the effects produced by the combination given below, upon which also I would be obliged for your opinion.

I use for the positive element an amalgamated cylinder of zinc, measuring five inches in diameter by seven inches in depth, and for the negative element carbon obtained from gas retorts. The zinc plate is immersed in a solution composed of,

Water	60 ounces.
Methylated alcohol	2 do.
Sulphuric acid	½ do.

—all by measure.

The carbon is immersed in the solution recommended by Wöhler and Bluff, consisting of,

Water	100 parts.
Bichromate of potash	12 do.
Sulphuric acid	25 do.

This seems to be, so far as I have yet tried it, an excellent combination for producing a large quantity of voltaic electricity.

On connecting pieces of iron or copper wire, same as inclosed, to the zinc plate, and then touching the carbon with the other end, it will, in a few seconds, be red hot for a little distance from the carbon. I think that my plate is too wide, and intend to have one tried three inches in diameter. This combination works for a good while, and the solution in the porous pot turns of a green colour when it is exhausted.

Yours, respectfully,

Dundee, April 22, 1863. A. Rattray.

THE INDUCTION COIL.

To the Editor of The Electrician.

Sir,—Dr. Callan, of Maynooth College, has recently increased very much the power of his coil. When last I wrote to you, the spark was about twelve inches, with a few small cells of his nitric acid battery. On last Tuesday he exhibited the coil to his class and a few friends.

The sparks were more than seventeen inches long.

The secondary wire (more than 30 miles long), is iron. Dr. Callan from experiment finds the iron better for induction.

He showed us also his *constant single fluid* battery, 100 cells, 4-inch plates. The light from carbon point was very fine, and rods of metals, steel, iron, &c., ½-inch diameter were fused, like thin wires in oxygen.—Yours most obediently, E. Kernan.

Clongower College, April 27, 1863.

To the Editor of the Electrician.

Sir,—I beg leave to acknowledge the great benefit I have derived by taking in your valuable journal since the first of its publication, especially on the subject of electro-plating and gilding; there are one or two questions I wish to ask you, which, I hope, you will not think it too much trouble to answer in your "Correspondents."

I have two bottles of plating and gilding solutions, and both have turned black; will you be kind enough to tell me the cause, and how to prevent it? Secondly, I am unsuccessful in my endeavours to replatinizing Smee's battery plates; will you please to give me full instructions how I can accomplish it? By doing so you will greatly oblige yours respectfully,

T. E. A.

18, *Duke Street, Mile End, New Town, April 27th*, 1863.

To the Editor of The Electrician.

Sir,—The commutator I alluded to in a communication contained in your impression is in the form of a wheel working horizontally; but as you seem to have tried a similarly constructed one, I have omitted sending a plan.

Rather long lengths of wire are shown in my sketch of a commutator (last week's impression); this is merely to make it easier to understand. If batteries are placed in a row, and current changer immediately over them, the terminals of batteries will be almost closed to terminals of current charges, very little wire being required to join them.

Exeter, April 23*rd*, 1863. E. F.

To the Editor of The Electrician.

Sir,—Could you inform me if aluminum has been employed to form a battery in conjunction with zinc, and if so, with what success. The platinised silver and copper plates in batteries are a continual source of annoyance from the platinum wearing off, the silver and the copper plates requiring constant cleaning.—Yours respectfully, P.H.A.

To the Editor of The Electrician.

" Dear Sir,—Will you kindly inform me as to the method gilders have of what they call "stopping," that is to say, to prevent the gold depositing all over an article when only a portion is to be done. If you will kindly inform me through your valuable journal you will oblige, yours truly,

J. Brittan, Jun.

To Correspondents.

M.—We have received from the Engineer of the Submarine Telegraph Company a distinct disclaimer of the expression relating to the deterioration of gutta percha under water, which was attributed to him in the report of the late meeting. As your letter bears mainly upon the expression in question, you will probably, like ourselves, be disinclined to insist upon the point which, through a misapprehension of the speaker's meaning, was thus suggested.

J. W. L.—Many thanks for your communication. A sketch of the commutator will shortly appear.

W. Tonkes.—We are obliged to defer the publication of your letter. The apparatus you suggest is easy of construction, and we shall be glad to bring it to the notice of our readers.

H. K.—We shall be glad to assist you as far as may be in our power if you will supply us with reliable data as to the results you have obtained. Important results are doubtless to be obtained in the direction you refer to.

H. W. Cook.—We insert this week an article which may throw some light upon the question you have taken up. This we leave for further discussion; but we may observe that the poles of a magnet are never at the extremities of a bar or horse-shoe.

END OF VOL. III.

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